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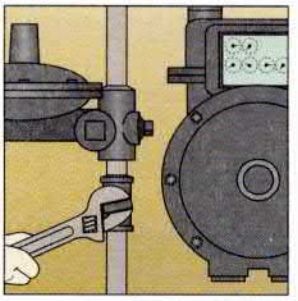

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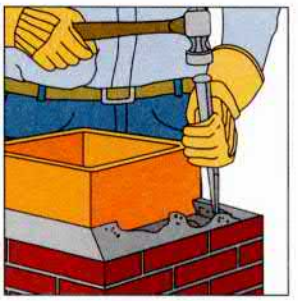

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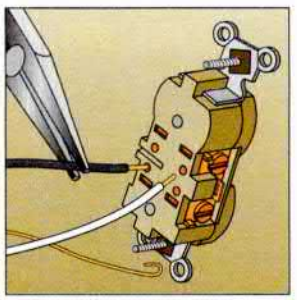

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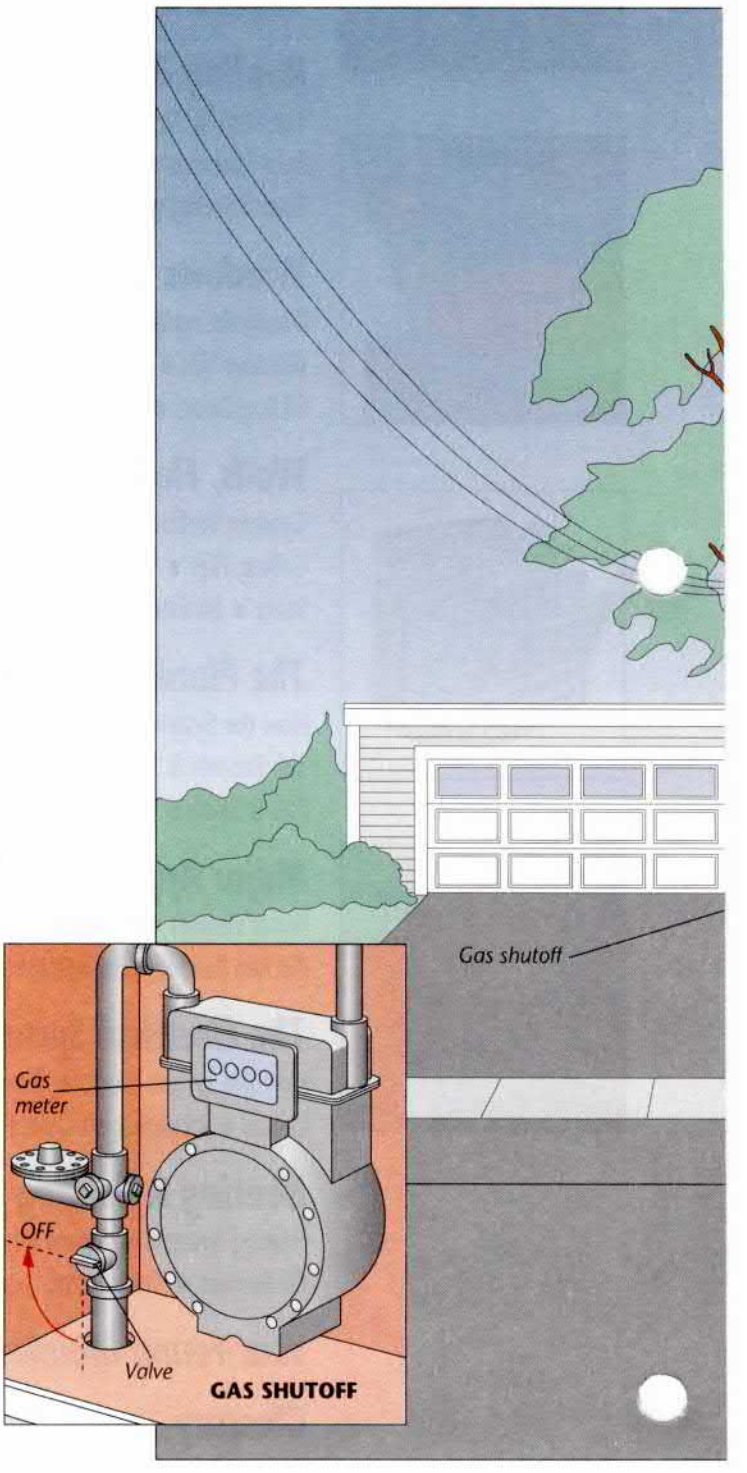
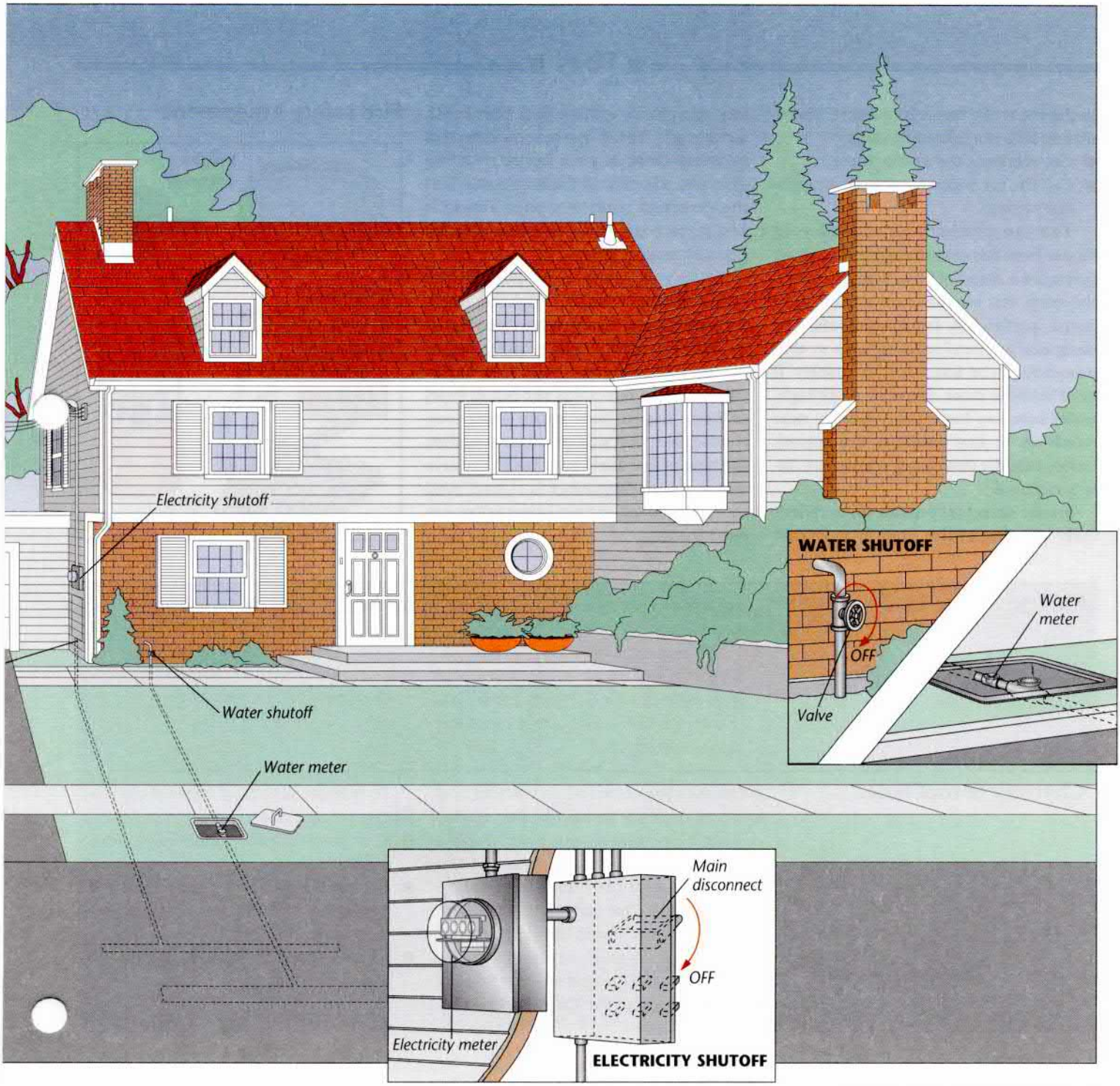


At some time, you may face a household emergency that requires you to shut off the supply of water, gas, or electricity to your home. This chapter explains how to locate and use these important shutoffs (shown below), so you can act promptly when the occasion arises. You'll also learn safe ways to handle specific emergencies, such as a grease fire in the kitchen or a toilet overflow in the bathroom.



HOME EMERGENCIES

Unfortunately, it is almost a given that you'll have to face an emergency situation in your home at one time or another. The most common household emergencies and what to do about them are described below and on the following pages. It's important to read this section now *before* an emergency occurs. Every member of your family should know the steps to take in case of a fire, and everyone should be familiar with the switches and valves that control the flow of water, electricity, and gas into your home. (If special wrenches are required to turn the valves, keep them close to the shutoffs.) Post emergency telephone numbers by each phone.

In the event of a natural disaster you may need to shut off the gas, electricity, and possibly the water. It's an excellent idea to have some basic emergency supplies—bottled water, nonperishable food, a portable radio, a flashlight with extra batteries, and a first-aid kit with instructions—on hand at all times.

Fires

In the event of a fire in your home, immediately take the following steps:

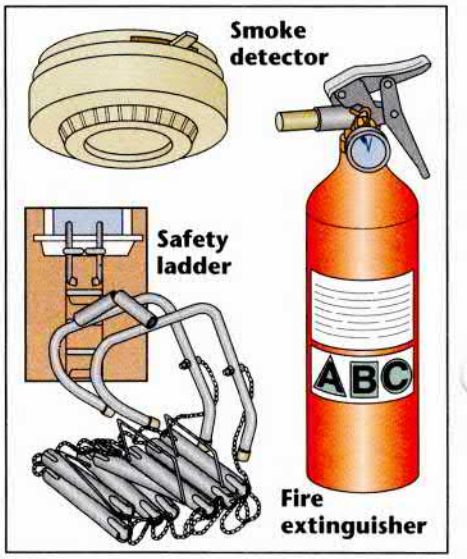
- Get everyone out of the house.
- Call the fire department from a neighbor's house.

You can protect yourself and your family from fire-related injuries by taking precautions ahead of time. With your family, map out escape routes from your house, particularly from bedrooms, and designate a central meeting area so that everyone can be accounted for quickly. If your home is more than one story high, make sure you have safety ladders near windows. If any windows are barred, ensure that the emergency releases are fully functional.

Smoke detectors provide an excellent early warning of fire; they're your first line of defense against fires that break out at night. Install one or more detectors on every floor of your house near the exits and adjacent to the bedrooms. Test the detectors routinely once a month and replace the batteries when needed (usually twice a year).

Equip your home with a portable fire extinguisher; it's useful for fighting small, contained fires. Extinguishers are classed by the type of fire they're designed to put out. If you have only one extinguisher, make sure it will put out all types of fires; if you have more than one, choose ones that will be effective against the type of fire likely to occur in the area where the extinguisher is stored. And learn how to use extinguishers *before* you need them.

Fire safety equipment



Kitchen grease fires

Here's how to extinguish fires that result from cooking:

- Small grease or oil fire in a pan: Turn off the heat and immediately cover the pan with a lid. DON'T pour water on a grease or oil fire. Water will cause the fire to spread.
- Oven fire: Turn off the heat and let the fire burn itself out. DON'T open the oven door. This will let in more air, feeding the fire and causing it to continue to burn.

Chimney & roof fires

A chimney fire occurs when the soot and creosote deposits inside the flue ignite, making a loud roaring noise and causing flames and sparks to shoot out of the chimney. A roof fire results from sparks traveling up the flue and igniting the roof; often, such a fire burns through the roof before it's discovered. In the event of a chimney or roof fire, get everyone out of the house and call the fire department.

To prevent such fires, observe the following precautions:

- Keep your chimney or stovepipe clean *(page 38)*.
- Do not burn large amounts of loose newspaper or other paper in your fireplace or wood stove.
- Install a spark arrester *(page 38)* on the top of your flue.

Plumbing Problems

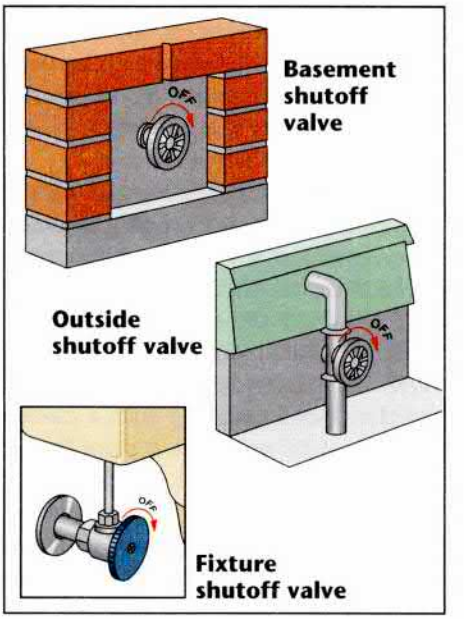
In a plumbing emergency, you'll need to stop the flow of water quickly before it seeps into floors and walls. To do this, you and each member of your family need to know the location of the shutoff valve for every fixture and appliance, as well as the main shutoff valve for the house, and how the shutoffs operate *(see at right)*. To learn how your plumbing system works, turn to page 108.

If the emergency involves a specific fixture or appliance, look for its shutoff valve and turn it clockwise to shut off the water to that fixture or appliance only. The valve is usually located underneath a fixture such as a sink or a toilet, or behind an appliance such as a clothes washer, at the point where the water supply pipe (or pipes) connects to it.

If the problem is not with a particular fixture or appliance—or if there is no shutoff valve for the appliance or fixture—use the main shutoff valve for the house to turn off the water. You'll find the main shutoff valve on either the inside or outside of your house where the main water-supply pipe enters. (In cold climates, the valve is usually just inside the foundation wall in the basement or crawl space.) Turn the valve clockwise to shut it off. If you need a wrench to turn the valve, keep one, specially labeled, near the valve so it is always handy.

If the main shutoff valve itself is defective and needs to be repaired, you'll need to call your water utility; they can send someone out with the special tool that's required to shut off the water at the street before it reaches your main valve. Then you can go ahead and fix or replace your cutoff valve.

Water shutoff valves



A leaking or broken pipe	■ Turn off the house's main shutoff valve to prevent water damage.	■ Make temporary repairs to stop the leak *(page 133)*; the pipe will have to be replaced as soon as it is convenient to do so.
An overflowing toilet	■ Reach inside the toilet tank, push the tank stopper down into the valve seat, and hold it there. ■ Turn off the water at the fixture shutoff valve underneath the toilet. If there's no valve there, turn off the house's main shutoff valve.	■ Unclog the toilet using a funnel-cup plunger or closet auger *(page 130)*.
A stopped-up sink	■ Shut off any faucet or appliance (such as a dishwasher) that's draining into the sink.	■ Unclog the sink using a plunger or snake *(pages 120-121)*. DON'T use a chemical drain cleaner if the blockage is total.
A faucet that won't shut off	■ Immediately turn off the water at the fixture valve underneath the sink. If there's no valve there, turn off the house's main shutoff valve.	■ Repair the faucet *(pages 111-116)* or, if necessary, replace it.
A steaming hot-water faucet	■ Open all the hot water faucets to relieve the overheated hot-water heater. ■ Turn off the gas or electric supply to the heater. ■ Let the faucets run until cold water flows from them (this indicates that the water in the heater is no longer overheated); then close them. ■ Call in a professional to make any necessary repairs to the heater.	

...HOME EMERGENCIES

Electrical Emergencies

Whether it's a power failure throughout the entire neighborhood or simply a malfunction in an electrical appliance, at some time you may have to cope with an electrical emergency. It's important to be familiar with the information below *before* the emergency strikes.

You should know how to turn off the house's electrical power during an emergency, as well as when you need to make electrical repairs. NEVER WORK ON ANY LIVE CIRCUIT OR ANY LIVE OR WET FIXTURE, APPLIANCE, RECEPTACLE, OR SWITCH. Shut off the power first and test the circuit carefully with a circuit tester *(page 22)* to be sure it's not live.

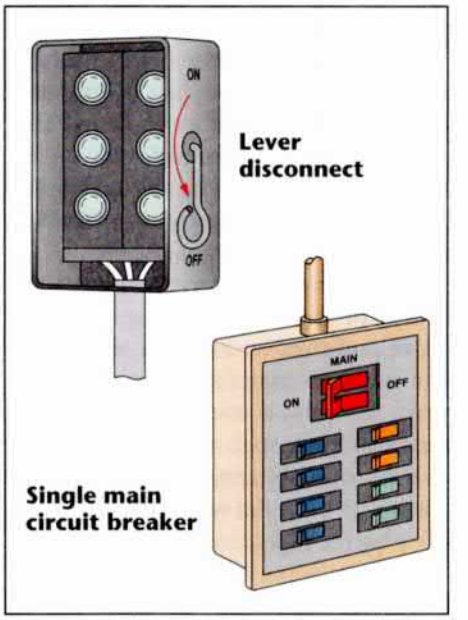
You can shut off the power to your entire electrical system at the main disconnect *(illustrated at right and discussed in detail on page 152)*; it's almost always located at the service entrance panel. This panel may be located on the exterior of your home—near the electricity meter—or on an inside wall directly behind the electricity meter.

Be sure everyone in your family knows where the service entrance panel is and how to shut off the power. You should also know how to turn the power back on, once it's safe to do so.

Whenever you work with electricity, be sure you observe the safety precautions on page 155. If you have questions or concerns about the wiring in your home, call an electrician.

It's smart to keep on hand a supply of the proper-size fuses (if your system is equipped for them) so you can replace any that have blown. Also have flashlights with extra batteries as well as candles and matches handy in case of power failures.

Electrical disconnects



A power failure	If the electricity fails suddenly in your house, determine first if it's just in your home or throughout the neighborhood. ■ If the outage affects the neighborhood, notify the utility company. ■ If the problem is just in your home, check for blown fuses or tripped circuit breakers. Replace any blown fuses or reset any tripped circuit breakers *(pages 151-152)* and test for a short circuit or overload *(page 154)*. Once the problem has been corrected, restore the power. ■ To retard food spoilage, don't open the refrigerator or freezer during the outage unless absolutely necessary.
A smoking or sparking appliance	■ Immediately unplug the appliance or shut off the wall switch that controls it. DON'T touch the appliance itself. Turn off the power to the circuit if you can't unplug the appliance. ■ When the appliance cools off, take it to a repair shop or ask a service representative to come to your home to make the needed repairs. ■ If the appliance catches fire, get everyone out of the house and call the fire department from a neighbor's house. DON'T use water on an electrical fire.
A smoking or sparking appliance plug	■ Cut off power to the outlet. Unplug the appliance by the cord and allow the plug to cool off. Check the plug and cord for signs of damage; replace them if they're defective *(pages 156-157)*. ■ Once the appliance plug is repaired, check for and replace a blown fuse or reset a tripped circuit breaker *(pages 151-152)*. ■ If you have inspected the plug and cord of the appliance and they are in good condition, and if the circuit is okay, then the fault is likely with the outlet. Replace it *(pages 160-161)*.

Gas Leaks

If you ever smell gas anywhere in your house, take the following precautions:

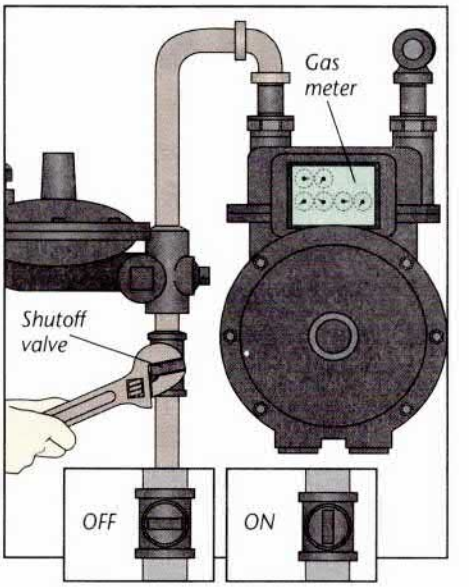
- Get everyone outside the house immediately.
- Use a neighbor's phone to call your gas company or the fire department.
- DON'T light a match and DON'T turn on or off any electrical switch. The danger of fire or explosion is severe. You should leave as many windows and doors open as possible to help clear the gas from the house.

Once you know everyone is safely out of the house, you can turn off the gas supply at the main gas shutoff valve (or you can wait for the utility company to arrive to do it). The valve is usually located on the gas inlet pipe next to the gas meter. To shut off the valve, use an adjustable wrench to turn the valve a quarter-turn (in either direction) so that the valve flats are in a closed position, perpendicular to the pipe, as shown in the illustration at right.

DON'T turn the gas back on until you've discovered the source of the problem and have corrected it.

In the event of a natural disaster, you may have to turn off the gas supply yourself. Make sure you and all members of your family know the location of the gas shutoff valve and how to operate it. To help your family identify the gas valve, attach a tie-on tag to the valve and label it. Leave an adjustable wrench in an accessible location so it will be close at hand in the event of an emergency.

Gas shutoff valve



When Should You Call a Professional?

Deciding whether to tackle a repair project yourself or have a professional do the work involves an honest assessment of four factors: the type of repair, your available time, your tools, and your skills. If your assessment convinces you to hire a professional, give careful consideration to your choice.

Do you have the time? If a repair must be made immediately to protect people or property, such as fixing a broken step or unclogging a backed-up toilet, and you can't do it right away, call a professional.

Where timing isn't critical, consider the size and scope of the work. A project that might take a professional a day or two could take you up to two or three weeks, working in your spare time—if you can find the extra time to set aside in the first place. Weigh the inconvenience of living with a repair in progress against the cost of having the work finished almost immediately.

Tools you'll need. Look into the cost of buying or renting any specialized tools required for a job, particularly if you don't expect to use those tools again. To repair your roof, for example, you must have special roof safety equipment; clearing a clogged main drain may call for a power auger. The professional's investment in the right tools for such jobs is part of his fee.

Your skills. Be realistic about your knowledge and skills. If you aren't sure how to make a particular repair after reading all you can about it and attending dealer demos, it probably makes sense to have the job done professionally. The same is true if you're not comfortable tackling the job—working on the roof, for example.

When appearance counts, such as with finish carpentry details or repairs to wood paneling, it may also pay to call in an expert if you have no woodworking experience.

Choosing a professional. The best way to find a competent professional is to ask your friends or neighbors for recommendations. You can also seek referrals from building material outlets and community colleges or local groups that offer building classes.

The Yellow Pages lists professional repair services under "Fix-It Services." For a specific repair, look under the appropriate category, such as "Electric Contractor," "Glass," or "Roofing Contractors." Local newspapers often carry ads for individuals specializing in home repairs.

Before you begin working with a professional, establish the fee and be clear about the specific work included. If you're paying an hourly rate, ask for an estimate of the time needed to complete the job. For a major repair, ask for references and compare the fees and the quality of work of several professionals before deciding.

Tools & Materials

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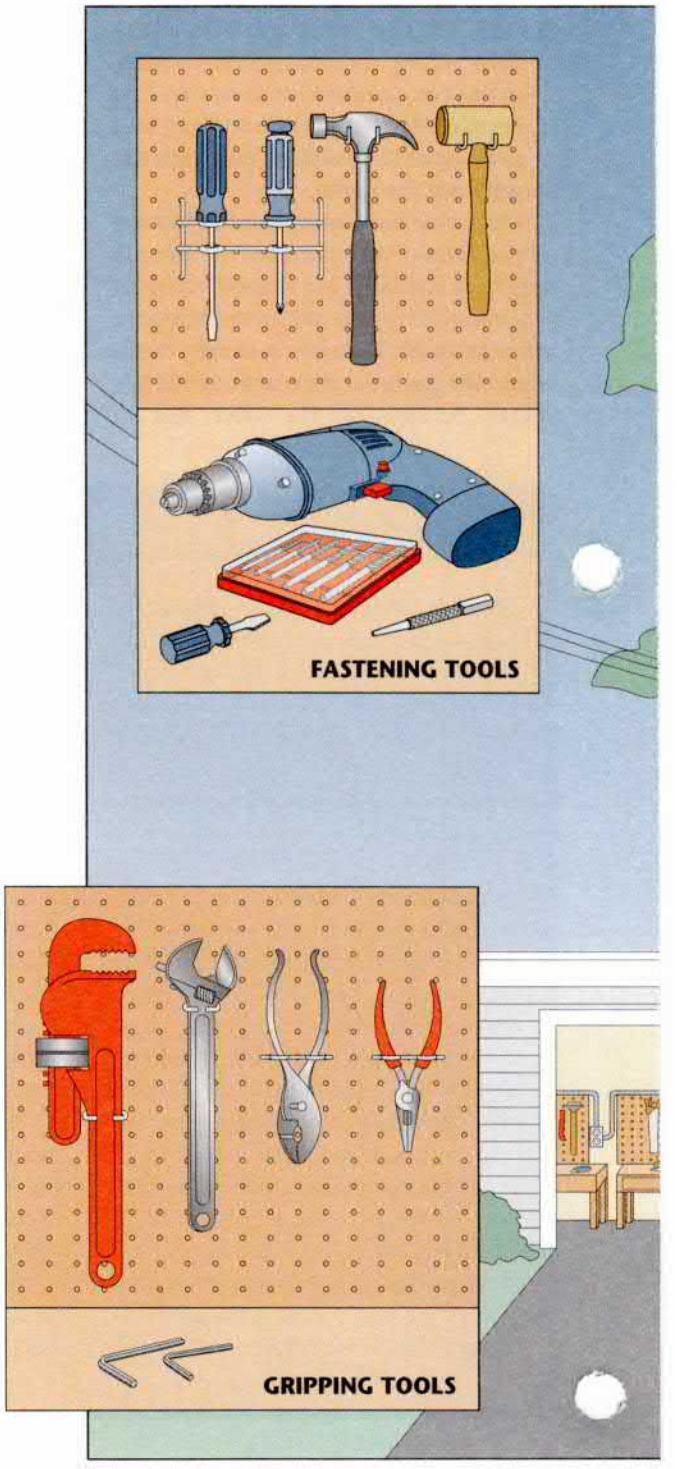
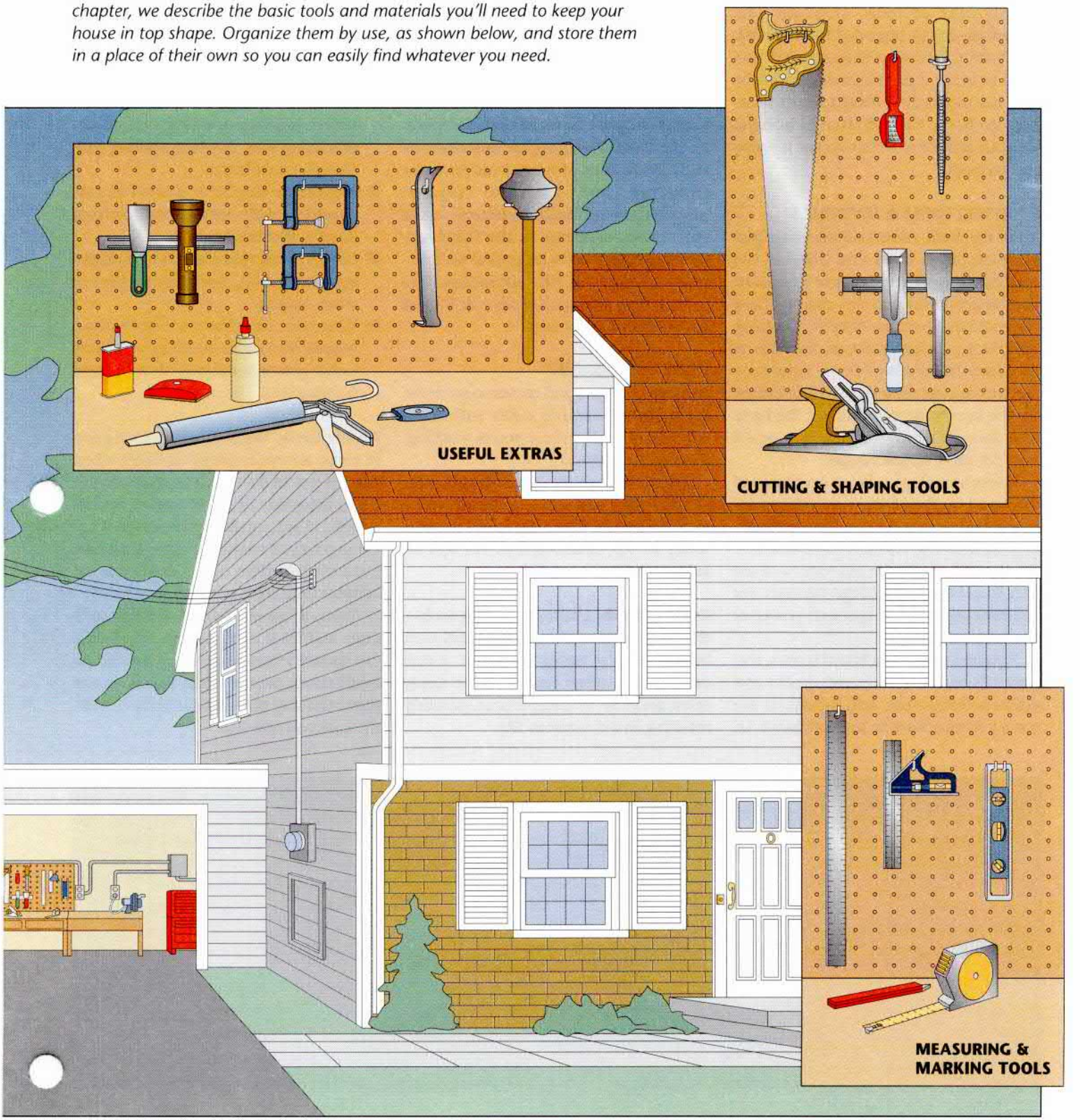


Hands can do amazing things. But to be "handy" in home repair means to have a good grasp of tools. Using a high-quality tool that's right for the job—and using it correctly—can help ensure the success of any repair. In this chapter, we describe the basic tools and materials you'll need to keep your house in top shape. Organize them by use, as shown below, and store them in a place of their own so you can easily find whatever you need.



TOOL SELECTION & SAFETY

The shelves of a well-stocked hardware store or home improvement center display an impressive and sometimes bewildering array of tools, fasteners, and materials—many intended for a specific use. Often, knowing exactly what you need to make a particular repair can be your key to success. This chapter explains how to choose the right tool or material for your project and how to use it safely and properly.

CHOOSING TOOLS & MATERIALS

All of the basic tools and materials pictured on pages 10-11 and listed in the chart below, as well as the more specialized ones described later in this chapter, have been selected because they're the most versatile type in their category, they can be used in many kinds of home repairs, or they're required for a specific job. Except for the handy electric drill, all the basic tools are hand tools—the only ones you'll need for most simple repairs.

Before you shop, take an inventory of the tools you already have and their condition. Buy tools as the need for them arises—and then buy the best you can afford. Quality tools make the job easier and are safer than bargain-basement varieties. For one-time repairs, you can rent power or specialty hand tools.

Fasteners such as nails and screws, and materials such as sandpaper, caulks and sealants, lubricants, and adhesives are items you may want to keep on hand. An assortment of various sizes of fasteners and washers, for example, can come in handy when you need to make a minor repair. Buy specialized items for particular jobs as you need them.

This chapter is divided into four sections. The first describes the tools in the basic collection, as well as some special-purpose types in each category. In the second section are descriptions and illustrations of specialized tools for plumbing and electrical repairs. Information on basic fasteners—nails and screws—appears in the third section *(for information on special wall fasteners, see page 93)*. The last section lists some of the basic materials you'll need and explains their uses.

USING TOOLS SAFELY

Proper techniques and common sense are the basics of working safely with hand and power tools. While you're working, observe these tips:

Position yourself securely and wear shoes with good ankle support when working so you won't slip or fall if something unexpected happens. For tips on ladder safety, see page 30.

Cutting tools. Use sharp cutting tools—they're safer to work with than dull ones because they're easier to control. A dull cutting edge often causes you to apply extra pressure to compensate, possibly resulting in a dangerous slip.

Safety equipment. Wear special safety equipment when necessary:

- Safety goggles with plastic lenses are a must when you're operating power tools, chipping or grinding, working above your head, or striking metal against metal.
- A dust mask protects your lungs when you're sanding or doing other dust-producing jobs, or when working with fiberglass insulation.
- A cartridge respirator (rented or purchased) provides extra protection from paint and solvent fumes.
- Gloves protect your hands from chemicals, insulation, and other abrasive or sharp objects.
- Wearing suitable ear protection whenever you're working with any noisy power tools will help prevent hearing loss.

Power tools. Work carefully with power tools, always unplugging them when they're not in use (even temporarily) or being adjusted. To guard against electric shock, check cords for damage. Plug three-pronged tools into three-pronged, grounded outlets only; don't use an adapter unless it's properly grounded.

Turn off an overheated tool immediately and let it cool. Always stand on a dry surface when you're working and, to avoid shock, be sure not to touch a water pipe with any part of your body or with the tool you're using.

The basic tool kit

Measuring & Marking	Fastening	Cutting & Shaping	Gripping	Useful Extras
Steel tape	Electric drill and bits	Crosscut saw	Slip-joint pliers	Utility knife
Straightedge	Claw hammer	Bench chisels	Needlenose pliers	C-clamps
Torpedo level	Nailset	Smoothing plane	Adjustable wrench	Caulking gun
Combination square	Mallet	Cold chisel	Allen-wrench set	Plunger
Carpenter's pencil	Screwdrivers (assorted sizes)	Perforated rasp		Sanding block
	Standard tip	File		Putty knife
	Phillips tip			Prybar
	Stubby			Flashlight
				White glue
				Light machine oil

BASIC TOOLS & TECHNIQUES

Having the tools you need on hand encourages you to tackle home repairs when they need to be done. This section is an illustrated guide to eight basic tool categories: measuring and marking tools; hammers and mallets; screwdrivers; drills; saws; pliers and wrenches; chisels, planes, files, and rasps; and special-purpose and miscellaneous items. You'll find out how to match the tool to the job, what to look for in a quality tool, and how to use common tools properly.

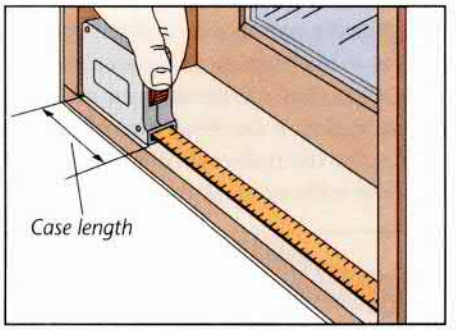
In addition to describing tools in the basic tool collection, this section explains tools you'll need for special jobs. You'll learn, for example, that a hammer is not just a hammer, but a claw, a ball-peen, or a tack hammer. Then compare your own tool collection with the one presented here so you'll know if you have the appropriate tool for your repair job.

Measuring & Marking Tools

For the best results when you make repairs, always measure and mark carefully. To be sure everything is straight, square, level, or plumb, you'll need the right tools.

Straightedges and tapes. Straightedges are rigid; tapes are flexible:

- A 3-foot straightedge allows you to measure short distances and/or mark cutting lines.
- A 25-foot flexible steel tape is for long or inside measurements *(see below)*. Look for a ¾-inch-wide tape with easy-to-read markings, a sturdy case, and a button that locks the tape in the extended position.

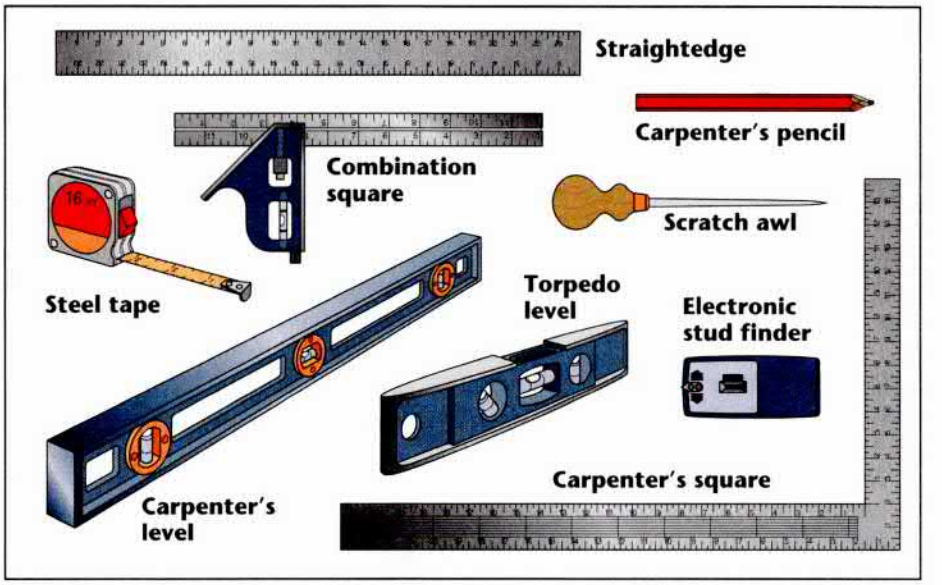


For an inside measurement, butt the tape's hook against one edge, the case against the other; measure, then add the case length to the measurement.

Squares. Use these layout tools to position accurate cutting lines:

- A multipurpose combination square helps you check for square, mark boards for crosscutting *(page 16)*, and measure both 45° and 90° angles. The square's removable sliding head can be tightened anywhere along the blade.

Selected tools for measuring and marking



- A longer carpenter's square is handy for squaring or marking sheet or wide materials. The edges of the blade and shorter tongue are graduated for both inside and outside measurements.

Markers. Accurate marking calls for sharp points, whether graphite or metal:

- A flat-sided carpenter's pencil won't roll when you put it down and sharpens to a fine, flat edge.
- A scratch awl or utility knife scribes a very fine, tight-to-the-line mark.

Measuring and marking tips. For accuracy, turn your measuring tool on edge. Mark distances with a V, placing its point exactly at the graduation point on the measuring tool. Draw straight lines with a straightedge and an awl or pencil, tilting the straightedge slightly so the point is flush against the straightedge. This will afford the greatest degree of accuracy.

Levels. With a level, you can gauge whether a horizontal surface is level or a vertical surface is plumb.

- An 8-inch torpedo level is good for leveling short spans.
- A 2-foot carpenter's level measures longer spans and affords a greater degree of accuracy.

To test a carpenter's level for accuracy, place it on a horizontal surface. Adjust the surface until the bubble is centered precisely between the markings. Then, turn the level end-for-end and replace it on the surface. The bubble should again be centered.

Hammers & Mallets

Though hammers and mallets are basically fastening tools, they also have other uses. A claw hammer is helpful for pulling out nails as well as for driving them; you can use a mallet to drive a chisel as well as to tap together a wood joint.

Claw hammer. The 16-ounce claw hammer is the most versatile hammer for home use. Look for a drop-forged steel head and a handle of wood, solid steel, or fiberglass (the last two may have cushioned grips that reduce vibration). The slightly crowned (bell) face allows a nail to be driven flush without marring the surface. The claws provide leverage for pulling nails.

CAUTION: Never use a claw hammer to drive a cold or other metal-handled chisel; the hammer's hardened steel face may cause metal chips to fly up; use a ball-peen hammer for this job.

Mallets and other hammers. Use these tools for special jobs:

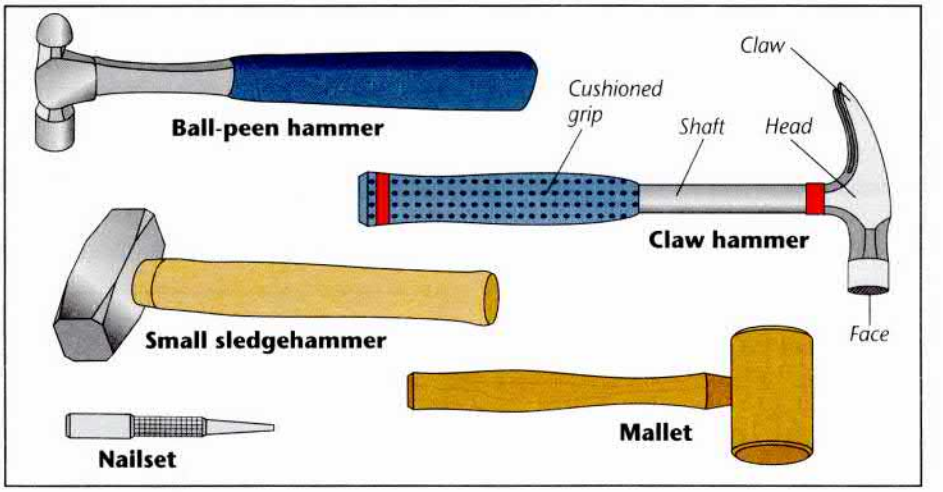
- A ball peen hammer—a special soft-headed steel type—is safe for working on metal, striking a cold chisel *(page 19)*, and driving hardened masonry nails.
- A small sledgehammer is handy for heavy pounding.
- A mallet—with a head of wood, hard rubber, or plastic—can be used to strike wood-handled or cold chisels, tap dowels into their holes, and tap together stubborn joints.

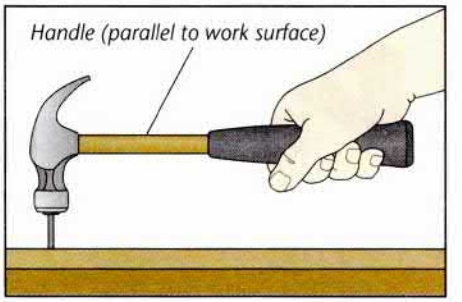
Hammering a nail. Fast, accurate nailing comes with practice. Experiment on pieces of scrap wood until you get a feel for it.

To start a nail, hold it with your fingers near its head. Choke up slightly on the hammer handle and use wrist action to tap the nail partially into the material. If the nail is too short to hold, insert it through lightweight cardboard, hold it with needlenose pliers, or place it between your flattened index and middle fingers.

After the nail is started, grasp the hammer handle near its end. Keeping your eye on the nail, swing your hammer with the wrist, elbow, or shoulder as the pivot point, depending on the amount of force needed.

Hammering tools





When the hammer hits the nail, the handle should be parallel to the material you're nailing.

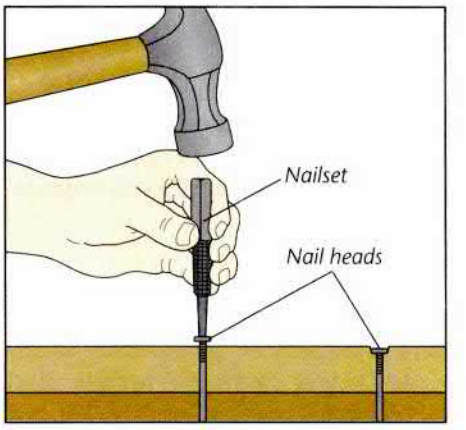
To prevent the wood from splitting when nailing near the end of a board, either blunt the nail tip by holding the head against a wood scrap and striking the tip gently with a hammer, or drill a pilot hole *(page 15)*.

Removing a nail. When you're removing a nail with a claw hammer, slip a thin wood scrap under the hammer's head to protect the surface; for a longer nail, substitute a thick wood block for more leverage. Use a prybar *(page 20)* when you need to pull out large, deeply driven nails.

CAUTION: Before using a hammer, check it; if it has a loose head or cracked handle, it can cause injury.

Using a nailset. To sink nails so their heads can be concealed, you'll need a nailset *(see above)*. Nailset sizes range from 1/32 to 3/32 inch; you can purchase them singly or in a set of assorted sizes.

Drive the nail to 1/8 inch above the surface to avoid marring the material. Hold a nailset slightly smaller than the nail head firmly against it *(see below)*; using a hammer, strike the nailset to sink the nail. Fill the hole with wood putty or filler.



A nailset's tip should be slightly smaller than the nail head's diameter. Sink the nail a distance equal to its diameter.

Screwdrivers

A screwdriver that slips when you're driving a screw is frustrating, dangerous, and will damage your work; avoid this by choosing the right screwdriver for the job.

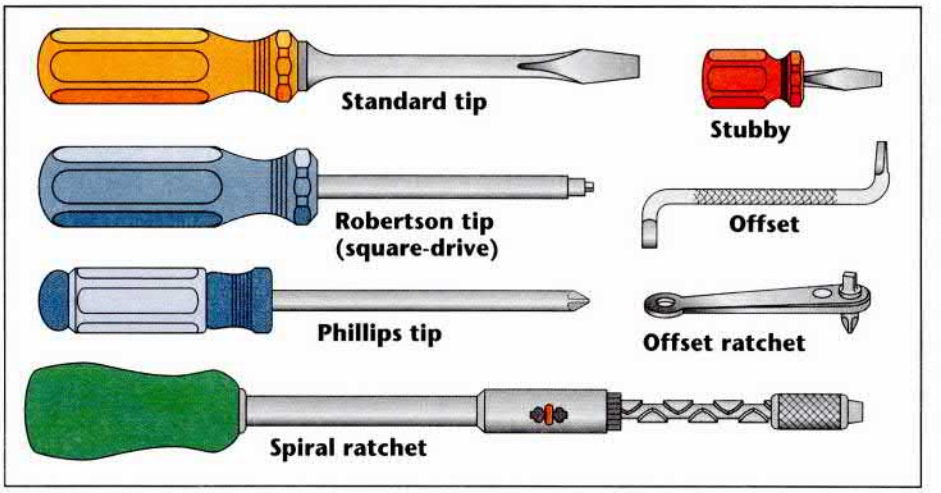
Types of screwdrivers. Choose screwdrivers with forged steel blades; plastic handles are the most durable.

- Standard (for straight-slotted screws), Robertson (for square-slotted screws), and Phillips (for cross-slotted screws) are basic screwdrivers. The square-shank type gives extra strength.
- A short-handled stubby screwdriver and an offset screwdriver are handy for work in tight spots.
- A spiral-ratchet screwdriver accepts many tips, so it replaces an assortment of screwdrivers. It's also a timesaver when you're driving or removing a number of screws, since pressure on the handle turns the tip.
- A variable-speed, cordless reversible electric drill with a screwdriver bit *(page 16)* drives and removes screws quickly and effortlessly.

Driving a screw. It's easier to drive a screw if you drill a pilot hole first *(see below)*. For maximum turning force, use a screwdriver with the largest handle and longest blade your working space will accommodate. Make sure the tip fits snugly in the screw-head slot. Lubricate the threads of wood screws with wax before driving them.

Removing a screw. If a screw slot is clogged, clean it with the tip of the screwdriver or a nail. To remove a stuck screw, tighten it a quarter-turn; then unscrew and retighten it repeatedly. If that doesn't work, douse the screw with penetrating oil (do not do this if the screw is in wood).

Assorted screwdrivers



PROFESSIONAL TIPS

MAINTAINING YOUR TOOLS

A light coating of machine oil keeps steel tools from rusting. Remove any rust spots with fine steel wool and oil. Keep tools sharp. Sharpen tools, such as chisels, knives, and planes, on an oilstone *(page 20)*; saws and other tools are best sharpened by a professional.

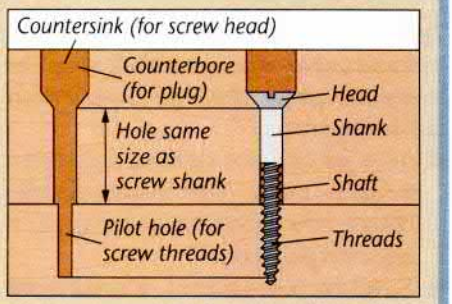
Drilling Pilot Holes for Wood Screws

In all but the softest wood, it's best to drill pilot holes for screws.

Choose a drill bit the diameter of the screw's shank and drill only as deep as the length of the unthreaded shank. In hardwoods, also drill a smaller hole below the shank hole for the threads; it should be half as deep as the threaded portion is long. Use a drill bit slightly smaller in diameter than the screw's shaft.

Flathead screws *(page 23)* can be countersunk so that they sit flush with the surface; sometimes the screw will be sunk deeper (counterbored) and the head covered with a dowel plug or with wood putty.

An electric drill's combination bit *(page 16)* can create counterbore, countersink, and pilot holes all in one operation. However, you can get the same result using three drill bits—one equal to the screw's head diameter, another equal to the screw's shank diameter, and a third equal to the screw's shaft diameter.

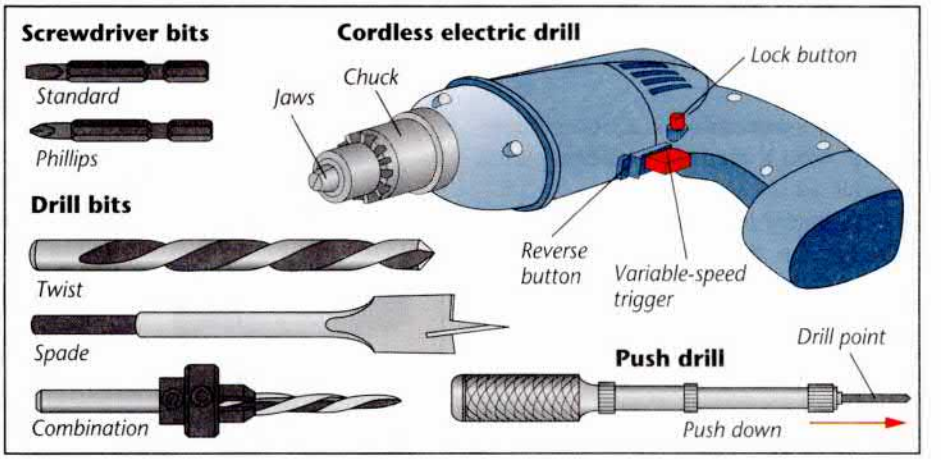


Drill to accommodate the shaft, shank, and head of a wood screw; if necessary, counterbore for a plug or putty.

Drills

For drilling holes, the tool of choice is a cordless portable electric drill. Electric drills are generally classified by the maximum size of bit shank that can be accommodated in their chuck jaws. A good choice is a 3/8-inch variable-speed reversible (VSR) drill. A plug-in electric drill is a good choice if you're willing to trade convenience for power and reliability. And a simple push drill is handy for simple jobs such as starting small holes.

Drills & Bits



Drill bits and accessories. A selection of bits are available for specific purposes:

- Multipurpose twist bits have two cutting edges along with spiral grooves to lift waste out of the hole as they turn. For durability in metal, buy high-speed steel bits.
- A spade bit cuts large-diameter holes speedily in wood.
- A combination bit drills pilot holes for screws *(page 15)*.
- Screwdriver bits can both drive and remove screws.
- A carbide-tipped masonry bit (not shown) drills holes in masonry and ceramic tile.

Accessories range from sanding discs to paint stirrers. A depth gauge will stop a drill at the correct hole depth.

Drilling techniques. Follow these tips for easy, safe drilling:

- Wear safety goggles when drilling.
- Clamp materials when possible.
- Match the drill speed to the job: highest speeds for small bits and soft wood, slowest for large bits and metal. As you drill, apply a small amount of pressure; leave the motor running as you remove the bit carefully from the material.
- Make a center hole (use a nail point, an awl, or, in metal, a center punch) before drilling to prevent the bit from "skating."
- Mark the hole depth on the bit with masking tape or a depth gauge.
- Release a stuck or binding bit by turning the drill off, then reversing it.

Saws

For most home repairs, handsaws are sufficient, though you may want to acquire a circular saw as well.

Types of handsaws. A saw's function is a product of its shape and blade size. The lower the point size, the rougher but quicker the cut.

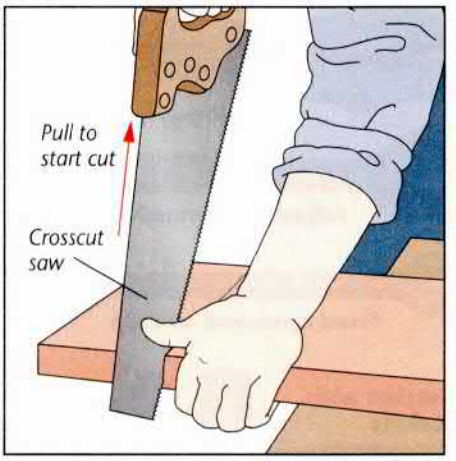
- An 8- or 10-point crosscut saw with a 26-inch blade, the most versatile choice, cuts boards across the grain; it also cuts plywood.
- A ripsaw (not shown), a specialized version of the crosscut saw , cuts with the wood grain. A ripsaw isn't an essential tool. A circular saw can be used effectively for both crosscutting and ripping.
- A backsaw, often used with a miter box, is for fine finish cuts on molding and other trim.
- A keyhole saw (also called a compass saw) makes cutouts in boards or walls.
- A Japanese style tooth-saw (not shown) makes faster, cleaner cuts and is widely available.
- A coping saw cuts fine, accurate curves in thin material; its narrow blade can be inserted in a starter hole near an edge and then attached to the saw frame.
- An adjustable-frame hacksaw, which accepts blades of various lengths, cuts metal; it's handy for cutting nail heads.

Using a crosscut saw. Brace a length of board securely on a sawhorse or worktable; support a wide plywood panel by placing it across sawhorses bridged by scrap 2-by-4s. Place the board or panel good side up.

Set the blade on the waste side of the cutting line so your piece won't be short. (The width of a saw cut—the kerf—is wider than the saw blade's thickness.)

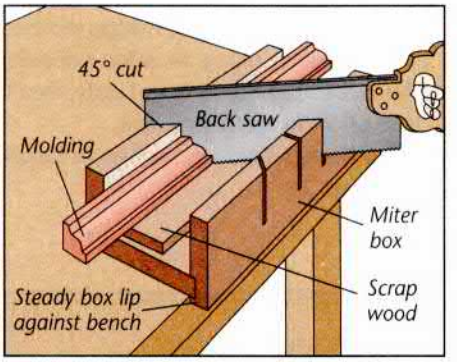
Hold the saw nearly vertical and, resting the blade near its butt end on the board, pull the saw toward you slowly once or twice, guiding the saw with the thumb of your free hand *(see facing page)*. Lower the saw angle to 45° and, using a push-pull motion and gradually lengthening the strokes, apply light downward pressure to finish the cut. If the blade veers off the cutting line, bend it back again; if it binds, hold the kerf open with a nail.

Near the end of the cut, reach around and support the waste piece with your free hand; holding the saw vertically, slowly finish the cut.



Grasp the handle of a crosscut saw firmly, but not tightly. Use your thumb to guide the start of the cut.

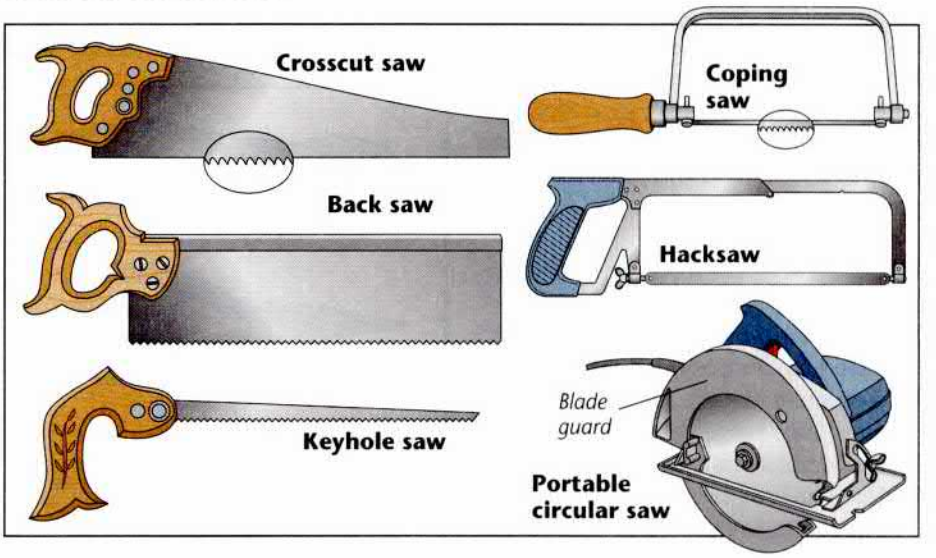
Using a backsaw and miter box. The backsaw's length must match the width of the miter box. The variety of angles you can cut depends on the box. Inexpensive boxes made from hardwood or plastic limit you to cutting 45° or 90° angles; more expensive metal boxes can be set to allow for cutting a greater range of angles.



In the miter box, align the cutting line with the desired angle, offsetting the piece slightly so that the saw's cut will fall on the waste side.

To use the box, mark the material. (Place a piece of scrap wood under it to protect the box.) Butt the piece against the far side of the box and, holding the wood firmly, pull the saw toward you, tilting the handle up slightly. Level the saw and complete the cut *(see at left below)*.

A selection of saws



Using a keyhole saw. To make a cutout in wood, drill a starter hole, insert the keyhole saw, and start the cut. (Once started, you can switch to a crosscut saw for a long straight cut.) Use a small 6- to 8-inch-long wallboard saw to cut gypsum wallboard. Here, you don't need a pilot hole; simply tap on the saw's handle end until the blade is started.

Using a coping saw. The blade may be positioned with teeth up, down, or to either side; rotate the blade holders to adjust the position.

For cutouts near an edge, slip the blade through a starter hole and then reattach it to the frame. For better control, clamp the material to a sawhorse or a vise. When cutting material held in a vise, point the teeth toward the handle and cut on the pull stroke.

Using a hacksaw. Choose higher blade-point sizes for thin materials, lower for thick metals. Insert the blade in the frame with the teeth pointing away from the handle. Set the blade tension by tightening the wing nut.

Place the material in a vise. With the steadying hand at the top front of the frame, use both hands to apply downward pressure only on the forward stroke. Keep the blade as square to the work as possible.

When cutting thin sheet metal, sandwich it between two pieces of wood and cut through all three materials.

Portable circular saw. A circular saw cuts much more quickly than a crosscut saw. A good choice is a 7 1/4-inch saw equipped with both depth and angle adjustment levers and upper and lower blade guards. An all-purpose combination blade comes with the saw; job-specific blades are also available.

Before you start, check the blade's cutting angle and depth. For most cuts, you will want the blade angled at 90° and protruding only 1/16 to 1/8 inch below the bottom of the material you're cutting into.

Place the material good-side down and rest the saw's base plate on it, lining up the blade with the waste side of the cutting line. Release the safety button and let the motor reach speed; then, holding the saw firmly, slowly feed the saw's blade into the material. As you reach the end of the cut, be sure you're in position to support the saw's weight.

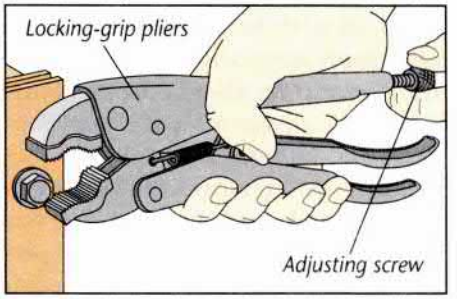
CAUTION: Keep the power cord free of the blade and wear safety goggles.

Pliers & Wrenches

Pliers and wrenches let you reach, grasp, or turn things that your fingers alone can't. When you shop for these tools, pay the price for quality. Look for drop-forged tempered-steel tools with jaws that operate smoothly.

Pliers. Most of the many types of pliers are used for gripping:

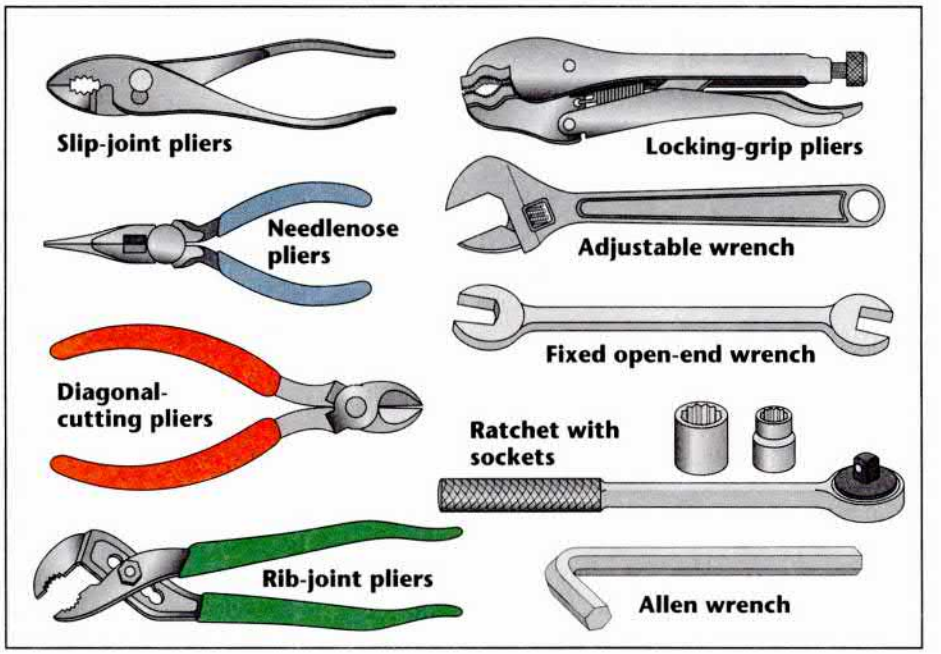
- Slip-joint pliers pivot on a bolt and have two jaw positions, one for gripping small objects, the other for large ones. Sizes range from 4 to 10 inches; the 6-inch size is a versatile first choice.
- Needlenose pliers, with their thin, tapered jaws, reach spots other pliers can't and are especially useful for making loops in wire. Choose a pair about 6 inches long, with insulated handles.
- Smooth-jaw diagonal-cutting pliers are handy for cutting wire and small nails or brads.
- Locking-grip pliers—straight jaw for sheet metal or, for pipes, curved jaw—perform the functions of pliers, a wrench, and a vise. An adjusting screw sets the jaws to the desired width; handles lock the pliers onto the work.



To clamp locking-grip pliers, turn the adjusting screw counterclockwise until the jaws grip the object tightly; squeeze the handles together to lock the pliers.

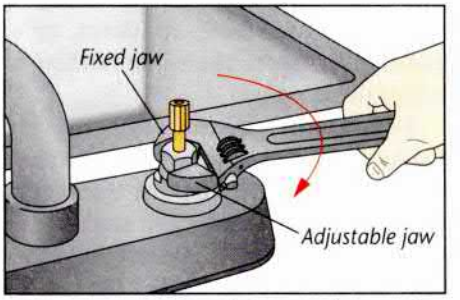
- Rib-joint pliers have a multiposition pivot that keeps the jaws parallel to better accommodate objects of different sizes. Before you exert any pressure on these pliers, be certain that the joint is engaged so you won't damage the pliers or injure yourself.

Common pliers and wrenches



Wrenches. To grip and turn nuts and bolts, you'll need the following types of wrenches:

- Adjustable wrenches in 6-, 8-, and 10-inch lengths meet most household needs. To avoid skinned knuckles, size the wrench to the fastener head, seat the head all the way into the jaws, and tighten the jaws.



Always turn an adjustable wrench toward its adjustable jaw.

- Fixed-end wrenches stand up under a lot of pressure, but you must have a size that exactly matches the fastener's head. These wrenches may be box-end, open-end, or combination types.
- A ratchet wrench with interchangeable sockets does what fixed-end wrenches do, but does the job faster. A lever on the handle reverses the turning direction of the socket, so there's no need to remove and refit the socket on the nut or bolt for each turn of the wrench.
- Allen wrenches loosen setscrews. You'll need a set that includes a range of sizes. When you're using an Allen wrench, be sure to tighten by hand only; don't use pliers to apply pressure.
- Pipe wrenches are described in detail on page 21.

PROFESSIONAL TIPS

PROTECTING THE FINISH

To prevent the jaws of pliers and wrenches from marring decorative finishes on fasteners, fixtures, and hardware, wrap the jaws with electrician's tape or masking tape.

Chisels, Planes, Files, & Rasps

Chisels, planes, files, and rasps are used to smooth, shape, and cut wood, metal, and other materials.

Chisels. These tools are used for cutting and shaping:

- A bench (bevel-edge) chisel shapes wood, marks cut lines, and cuts mortises. Choose a blade slightly narrower than the area you're working.
- Cold chisels cut metal, masonry, or ceramic tile. Drive them with a mallet or ball-peen (never a claw) hammer and wear safety goggles.

Using a chisel. Be sure to observe the following precautions:

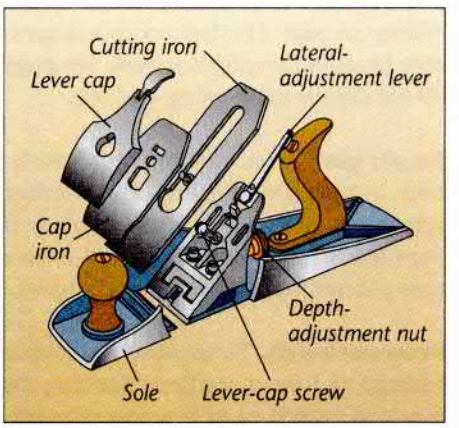
- Keep both hands positioned behind the chisel's cutting edge; never cut toward yourself.
- To mark cut lines or remove some wood, tap a plastic-handled chisel with a hammer, a wood-handled chisel with a soft-faced mallet.
- For a shallow cut, work with the beveled edge down. Turn bevel up for deep cuts. When marking a cut line or cutting up to a line, the bevel should face the waste material.
- To cut a mortise with a chisel, see the instructions on page 69.
- Keep your chisel sharp. Hone it, beveled-edge down, on an oilstone *(page 20)*, holding the chisel at an angle that matches the bevel. Turn the chisel over and, keeping it flat against the stone and using a circular motion, remove any burrs.

Planes. These tools smooth and trim wood by removing it in thin layers:

- Bench planes, used for with-the-grain finishing, include jack, jointer, and smoothing planes; the last is best for general use.
- Block planes are used to shape and smooth end grain.

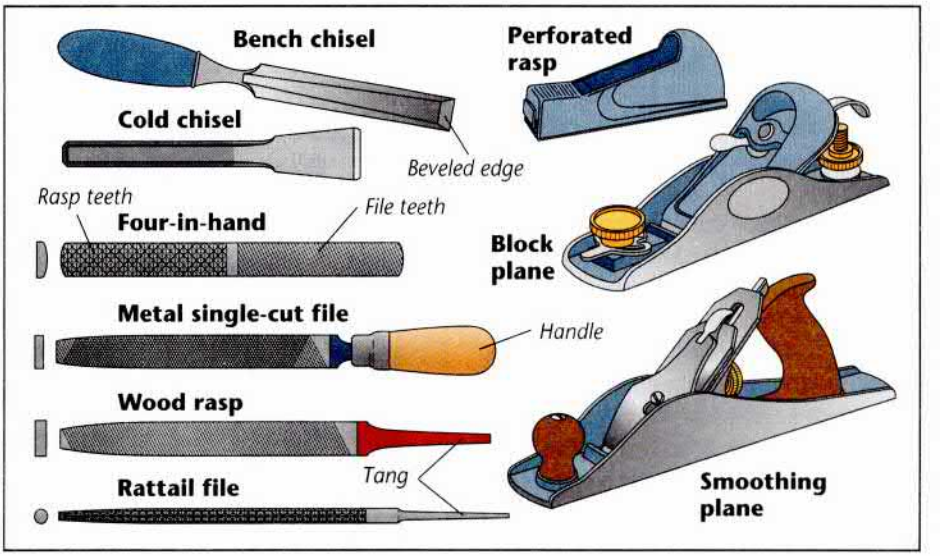
Adjusting a plane. To adjust a bench plane, remove the lever cap, cap iron, and cutting iron. Loosen the screw and align the irons so the cutting iron projects about 1/16 inch; tighten the screw and reassemble. Turn the plane over and sight down its sole. If the blade is out of square, use the lateral-adjustment lever. To adjust blade exposure, turn the depth-adjustment nut. Block plane adjustments vary by model.

CAUTION: A dull cutting iron can be dangerous. To sharpen it, stroke it repeatedly on an oilstone *(page 20)* and bevel it down.



In order to adjust a plane, check the iron alignment and blade squareness, and then the projection.

Smoothing, shaping & cutting tools



Files and rasps. Generally, files abrade either metal or wood. Rasps, for example, are for wood only; they differ from files in that they have individual triangular teeth.

- A perforated rasp both removes and smooths wood and, with the proper blade, gypsum wallboard, soft metals, and plastic.
- A half-round single-cut file and the coarser double-cut file (not shown) smooth both wood and metal.
- A rattail file, thin and rounded, smooths inside curves and holes.
- A wood rasp removes material from soft wood.
- A versatile four-in-hand is half file, half rasp.

Using files and rasps. Files and rasps should be used to cut on the forward stroke, in one smooth action, and lifted off the work on the return. With one hand on the handle and the other hand on the end, apply even downward pressure. Keep the tool level and at a slight angle to the work.

NOTE: These tools are sold without handles. When you purchase a file or rasp, buy a handle to cover the sharp end, or tang.

Other Useful Tools & Equipment

Though you may not think of some of the items on this page as tools, you'd be hard pressed to complete many home repair and maintenance jobs without them.

Knives and cutters. This category includes tools both for cutting and for patching:

- A utility knife cuts everything from string to ceiling tile. Choose a metal one that has a button to retract the blade when it's not in use.
- Putty knives and taping knives *(page 85)* apply patching material and adhesive, and also handle scraping chores. Choose a flexible taping knife about an inch wide and a narrow, stiff-bladed putty knife.
- Tin snips cut sheet metal and window screening; their blades may be straight or curved (use the curved ones for making irregular cuts). Don't use tin snips to cut nails or wire.
- A glass cutter with a small cutting wheel at its tip is used to score glass for cutting.

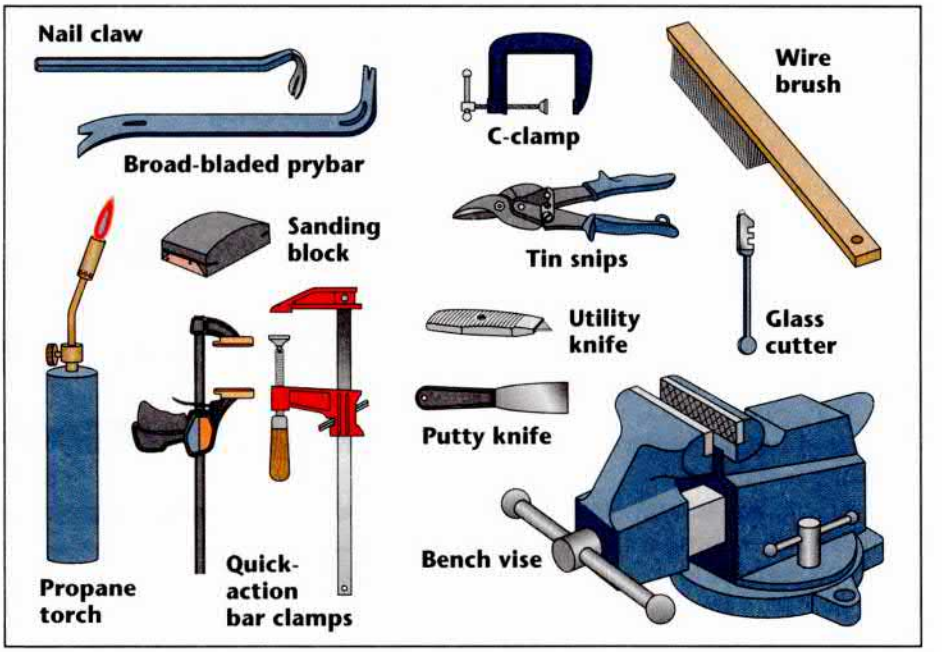
Clamping devices. Secure materials for cutting and hold glued materials while they dry with this equipment:

- Quick-action bar clamps are basic and necessary for most work and come in a variety of sizes.
- A bench vise with serrated jaws clamps and holds pieces of wood as well as metal. Be sure to pad the jaws with scrap wood to protect your work when necessary. If you'll be using wood a lot, a woodworker's vise (not shown) is preferred.

Sanding block. For finishing woodwork, insert sandpaper in a rubber or plastic sanding block, or wrap the paper around a 2-by-4 wood block and secure it with staples.

Prybars. These tools are essential for demolition jobs both inside and outside your house:

Useful extras



- A nail claw pulls large nails with its curved claw, saving wear and tear on your claw hammer.
- A broad-bladed prybar or a larger wrecking bar removes wall materials from studs, pulls out large nails, and does a multitude of other removal and demolition jobs.

Caulking gun. For general maintenance and repairs, a double-strap caulking gun *(shown on page 11)* that accepts disposable drop-in cartridges is best. See page 49 for details on loading and use.

Staple gun. Attach ceiling tiles, insulation, lightweight paneling, and window screening with a heavy-duty staple gun (not shown). Especially handy is one that accepts staples of various lengths.

Propane torch. To sweat-solder copper tubings or loosen resilient flooring for removal, you'll need a propane torch. Follow the manufacturer's instructions for lighting and using the torch. Protect the surrounding area with a flameproof pad.

Oilstone. To keep your tools' cutting edges sharp, use an oilstone at least 6 inches long with a fine and a coarse side (not shown). Apply a little light oil, preferably cutting oil, to the surface during use to keep the pores from clogging. Store the stone carefully; oilstones break easily.

Other aids. These miscellaneous items will come in handy:

- A lantern flashlight or a trouble light (not shown) frees your hands for work, especially handy for dark corners.
- A wire brush removes flaking paint, rust, and grime from metal.
- Disposable plastic drop cloths (not shown) are handy for painting jobs, but they don't hold up very well. Underlay them with canvas cloths for better protection.
- Extension cords (not shown) are often necessary when you're using power tools. Use three-wire grounding cords, matching the gauge and length of the cord to the tool's ampere rating (check the owner's manual of the power tool you are using).

SPECIALIZED TOOLS

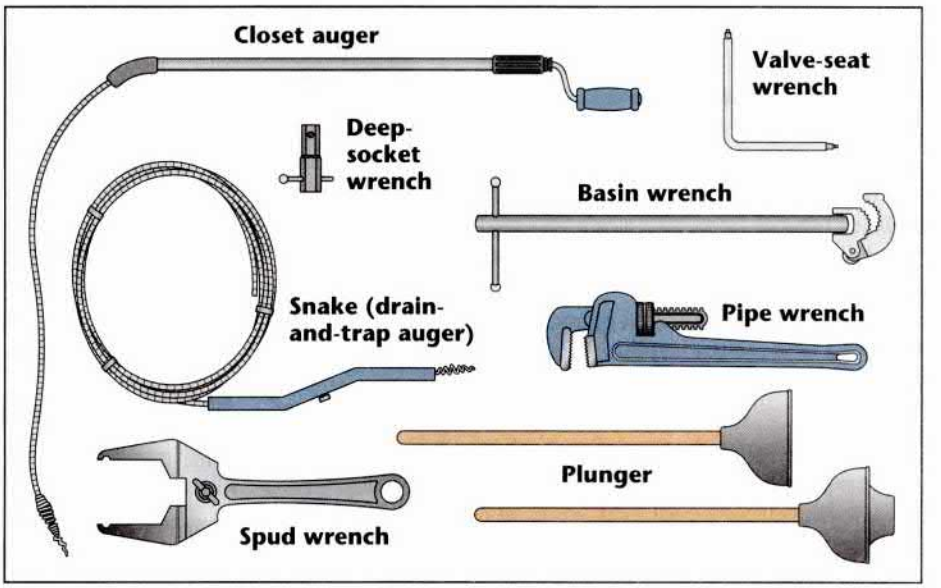
Plumbing Tools & Materials

Tools you'll need for plumbing repairs include some that are part of the basic tool collection or suggested additions to it, as well as special tools and materials used specifically for fixing pipes and fixtures.

Among the basic tools that you should have on hand are standard and Phillips screwdrivers for faucet screws, adjustable along with open-end wrenches for nuts and bolts, and rib-joint pliers to remove some fittings. You may also need an offset screwdriver with standard and Phillips tips, a set of Allen wrenches for setscrews, and a hacksaw blade to cut off rusted bolts and nuts.

Specialized plumbing tools fall into three categories: drain-clearing tools, wrenches, and job-specific tools. You'll also want to have certain materials handy for temporary and permanent repairs.

Tools for plumbing repairs

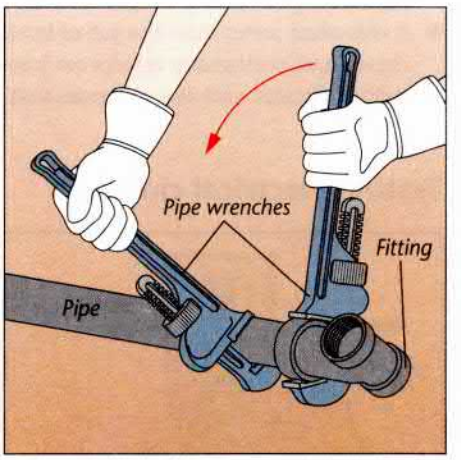


Drain-clearing tools. These three tools are used to clear plumbing clogs in fixtures and drains:

- A plunger uses alternate pressure and suction to dislodge clogs in drains and plumbing fixtures. The funnel cup type, shown at right above, is designed for toilets, but it folds flat for drains. For tips on its use, see page 130.
- A snake (also called a drain-and-trap auger), available in lengths from 10 to 75 feet, stretches into a drain to clear a deep blockage. Locking the snake's thumbscrew and turning the handle drives the corkscrew-like tip into the clog.
- A closet auger is designed specifically for toilets; its bent shaft guides the 3- to 6-foot cable into the toilet's trap *(page 130)*.

Wrenches. In addition to the wrenches mentioned above, you may need some more specialized ones.

- A spud wrench, with its wide, smooth jaws, is useful for unfastening extra-large nuts and fittings on sinks and some toilets.
- Pipe wrenches have serrated jaws for gripping fittings and galvanized or cast-iron pipe. Use them in pairs on pipe, as shown below: one wrench holds one section of pipe stationary; the other turns the pipe or fitting.



The pipe wrench at left holds the pipe while the one at right tightens the fitting. To loosen the fitting, reverse the position and direction of the wrenches.

- A basin wrench's long handle reaches out-of-the-way couplings and nuts. Its jaws can tighten or loosen nuts.

Job-specific tools. Certain jobs call for very specialized tools:

- A valve seat-wrench and valve-seat dresser are tools you need for compression faucets *(pages 111-112)*. The former has both a hexagonal and a square end to remove valve seats; the latter cleans corroded seats and smooths pitted, nonremovable seats.
- A deep-socket wrench removes the hard-to-reach packing nut on a tub compression faucet *(page 118)*.

Materials. It's a good idea to keep certain items for plumbing repairs on hand. A tube cutter cuts through flexible and rigid plastic tubes. Plastic, electrical, or auto hose tape can be useful for a temporary repair of a leaky pipe or trap; to protect fittings, wrap tool jaws with electrical tape.

For permanent repairs, check your faucet sizes and stock assorted washers, brass screws, O-rings, and packing. You'll also need pipe joint compound to ensure you get a tight seal between threaded pipes and fittings. Keep some light penetrating oil handy for loosening stubborn or "frozen" connections.

...SPECIALIZED TOOLS

Electrical Tools & Materials

For simple electrical repairs, you'll need basic tools, as well as a few specialized ones. Standard and Phillips screwdrivers are very helpful. Use needlenose pliers (preferably with insulated handles) to form wires into loops, diagonal-cutting pliers to snip wire in tight spots, and Allen wrenches to turn setscrews. Have a flashlight or trouble light, too, since you may need to turn off the power to the room where you're working.

Specialized electrical tools include those for wires and testing circuits. You'll also want to stock assorted materials.

Wire-handling tools. Special tools often make working on wire easier:

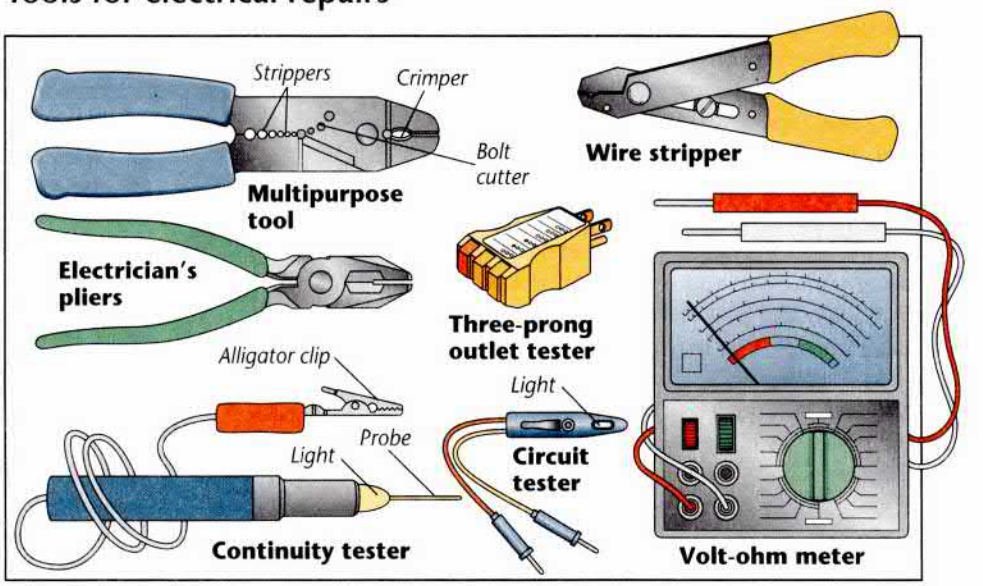
- A multipurpose tool cuts wires and bolts, crimps wires, and strips off wire insulation.
- A wire stripper removes wire insulation. Set the adjustment screw to the correct gauge, place the stripper on the wire at an angle, close the handles, and rock the tool. Then pull off insulation.
- Electrician's pliers (also called lineman's pliers) are for gripping, and to cut and twist wires.

Testing devices. With these devices you can determine if the power is on and if it's flowing properly:

- Three-prong outlet tester tests for electrical faults in outlets.
- A circuit tester (120- to 240-volt range) tests whether a circuit is live or dead. Check it by grasping the tester's leads by the insulated areas only and, on a receptacle, for example, inserting the probes into the slots *(see at right)*. If the tester's bulb lights, the circuit is live. NEVER WORK ON ANY LIVE CIRCUIT, FIXTURE, RECEPTACLE, OR SWITCH. Shut off the power to the circuit and test it again before doing any electrical work.
- A battery-operated continuity tester is used with the power off to test continuity of a circuit, switch, appliance, lamp *(see at right)*, or fuse. To check a cartridge fuse *(page 152)*, for example, touch the probe to one contact, the alligator clip to the other. If the bulb on the tester lights, the fuse is not blown and can be used.

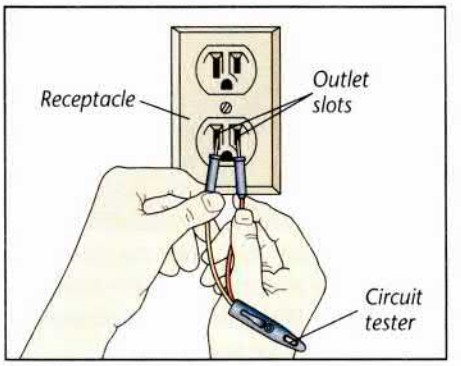
  CAUTION: Shut off power to the circuit or unplug the device you're testing before positioning the probe or clip.
- A volt-ohm meter does the job of both circuit and continuity testers on low-voltage circuits, and also measures voltage and ohms (resistance). It's useful for testing appliances as well as low voltage electrical devices such as the transformer on a doorbell *(page 162)*. For instructions on use, read the owner's manual. CAUTION: Shut off the power to check resistance or continuity.

Tools for electrical repairs

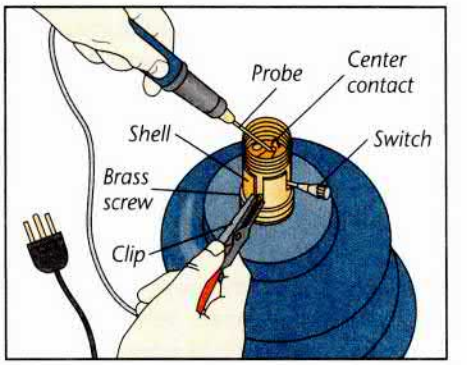


Materials. If you have fuses, stock replacements. Also, keep wire nuts of various sizes and electrical tape on hand.

Testing electrical circuits



Check a receptacle with a circuit tester before doing any work. If the bulb lights, the electricity is still on. You must shut it off before working on the receptacle.



With the lamp unplugged, check its switch with a continuity tester. If the tester lights when the switch is turned on, the switch works.

FASTENERS

Nails

Probably the most popular fasteners, nails are quick and simple to use. Size—specified in "pennies" and abbreviated "d"—indicates length and diameter, and ranges from 2d (1 inch) to 60d (6 inches). When possible, use a nail that is two-and-a-half times the thickness of the member being fastened.

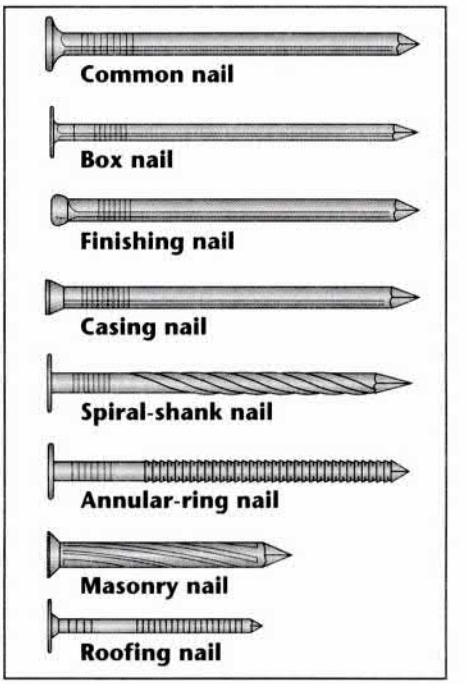
Nails for general use. Choose from among the following types of nails:

- Common nails and thinner but similar box nails, recommended for general use, have broad heads that won't pull through. Coated ones have more holding power than uncoated ones.
- Small-headed finishing or casing nails are suitable for cabinets and trim. Casing nails hold better, but finishing nails leave a smaller hole.
- Brads (not shown) are tiny finishing nails used to fasten thin moldings and paneling.

Specialized nails. These fasteners improve holding power in certain specified applications:

- Spiral-shank and annular-ring nails have grooved shafts that act like screws for fastening flooring as well as subflooring.
- Wallboard nails (not shown) are used for fastening gypsum wallboard on wall studs.
- Shingle nails (not shown) are used to attach wood siding and roofing shingles to the house.
- Masonry nails, made from hardened steel, penetrate and hold in masonry. When you drive in these nails, wear safety goggles and use a ball-peen hammer.
- Roofing nails have large, flat heads that resist pull-through. To prevent corrosion, use aluminum, not galvanized, nails on aluminum roofs and siding.

Types of nails



Screws

When you need plenty of holding power, your best choice is screws. They can be tightened or removed without damaging the material they're in and, providing you make a pilot hole, they won't split wood.

Screws come in lengths ranging from 1/4 to 6 inches and in diameters from No. 0 (1/16 inch) to No. 24 (almost 3/8 inch). Ideally, a screw should be long enough so that two-thirds of its length enters the member being fastened to. In general, the thicker the diameter for a given length of screw, the greater its holding ability.

Wood screws. These have smooth shanks and are threaded along about two-thirds of their length. Wood screws come in three configurations:

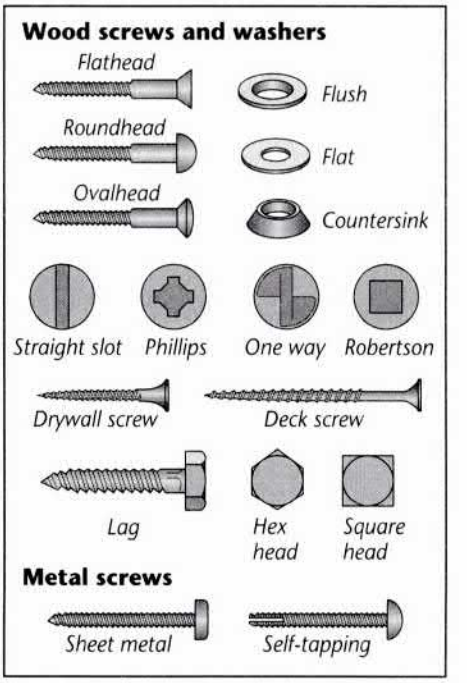
- Flathead screws can be driven flush or counterbored *(page 15)*.
- Roundhead screws have heads that sit atop surface; best choice when top piece is too thin for countersinking.
- Ovalhead screws, usually brass or chrome; suitable for decorative uses.

Washers—flush for flathead screws, flat for roundhead screws, and countersink for ovalhead screws—can be used with any of these screws.

Other types of screws. These are for special applications:

- Lag screws, with square or hexagonal heads, range from 1 to 6 inches long and from 1/4 to 1/2 inch in diameter, and offer extra holding power in wood. Turn them with a wrench.
- Sheet-metal screws and self-tapping screws have pan or round heads, and threads from head to tip.
- Deck screws are rust-resistant with fast-driving threads; also with sharp points that require no pilot holes.
- Wallboard screws have Phillips heads and flat-black finish; they range from 3/4 to 3 inches in length.

Types of screws



BASIC MATERIALS

Some simple home repairs, such as patching cracks in a wall or sealing air leaks around windows, require just a few tools. However, they also involve choosing the appropriate materials for each repair. The information below will help you choose abrasives, adhesives, caulks, sealants, lubricants, and patching materials. Purchase good-quality materials—they make the time and energy you invest in a project worthwhile.

Abrasives. When you're removing small amounts of wood or paint or smoothing a surface, you'll need an abrasive—steel wool or sandpaper. Steel wool can be used on wood or metal; grades run from 3 (coarse) to 0000 (superfine). Sandpaper comes in a variety of types *(see chart below)* and grades. The type is usually labeled on the backing, along with the following specifications:

- Grade is indicated by a grit number from 12 to 600; 50 (very coarse) to 220 (very fine) is the common range. Silicon carbide is available up to 600 grit. Coarse grades are for rough work, fine grades for finishing.
- Backing may be cloth or paper. Cloth-backed types can be used wet or dry; paper-backed types are most often used for dry-sanding.
- Coat—open or closed—indicates grit density. Open-coat resists clogging, but cuts more slowly than closed types.

Glues and adhesives. Ranging from all-purpose white glue and yellow carpenter's glue to special mastics, adhesives vary in strength, water-resistance, ability to fill gaps, and setting time *(see chart on facing page)*.

Caulks and sealants. Caulking and sealing compounds are used indoors and outdoors. Caulking dries hard whereas sealants dry pliable and are best used for sealing joints. Most are available in drop-in cartridges for use with a caulking gun *(page 49)*. These compounds vary in both price and composition; generally, the best are also the most expensive.

For information about types of caulks and sealants, see the chart on the facing page. NOTE: The chart lists major categories of caulks and sealants; many types are available within some categories. To choose the best type for a particular job, consult your local building supply center.

Lubricants. You'll use these lubricants over and over again:

- Penetrating oil loosens rusted and balky screws and nuts. It's especially helpful for freeing stubborn plumbing connections.
- Light machine oil silences any squeaking hinges, and also lubricates and protects tools; use it with steel wool to remove rust.
- Powdered graphite (without oil) is ideal for lubricating locks because it doesn't attract dirt and dust.
- Silicone spray is an all-purpose lubricant that doesn't congeal during cold weather.
- Paraffin wax helps windows and sliding doors glide more easily, and makes screws easier to drive.
- Plumber's grease is handy for lubricating some plumbing parts.

Patching materials. These materials are essential for both indoor and outdoor repairs:

- Wood putty, available in stick or paste form, fills gouges, cracks, and nail holes in wood. Putty can be sanded and painted over. You can buy putty in colors to match most woods, but you may have to add coloring to it to blend with a particular finish.
- Patching plaster fills large or deep holes and cracks in plaster and gypsum wallboard.
- Spackling compound fills small indentations, narrow cracks, and nail holes in walls.

You can also buy specially formulated patching materials, such as glazing compound for window glass; vinyl, epoxy, or latex concrete patch; grout for ceramic-tile joints; stucco patching compound; butyl gutter seal; mortar for brick joints; and plastic metal fillers.

Abrasives

TYPE	CHARACTERISTICS	USES
Sandpaper		
Silicon carbide	Hard, sharp; cuts well, but is brittle; can be used wet or dry	Good for wet-sanding soft metals, joint compound on gypsum wallboard, glass, and plastic; good for dry-sanding wood and finishes on hardwood
Aluminum oxide	Durable, sharp	All-purpose abrasive for wood and soft metals
Garnet	Hard, sharp; medium quality	Good for wood
Emery	Durable	Polishes metal (use with oil); not to be used on copper to be sweat-soldered
Steel wool	Flexible; very gentle (finest grades); can be used either dry or with oil	Removes rust from metal, paint from glass; good for rubbing down finish coats on wood

Adhesives

TYPE	CHARACTERISTICS	USES
White (common household) **glue** (polyvinyl acetate)	Rigid bond; can be sanded; softens above 150°F; not waterproof	Good for general home repairs, except for metal and high-heat or high-moisture applications; bonds indoor wood joints (must be clamped); fills tight gaps between materials
All-purpose (household) **cement**	Moderately strong bond; dries fast; water-resistant	Good for bonding wood, some vinyl, metal, leather, and paper products
Yellow (carpenter's or wood) **glue** (aliphatic resin)	Rigid bond; dries clear and can be sanded; heat-resistant; not waterproof	Bonds wood (must be clamped); fills tight gaps between materials
Contact cement	Water-resistant; bonds on contact	Bonds thin materials to a base
Epoxy resin	Strong, rigid, permanent bond; waterproof; mix before using	Different formulations available for bonding most like and unlike materials; some types patch water pipes, fill gaps between materials
Urethane glue	Strong, permanent bond (but not as strong as epoxy); waterproof	Good for bonding wood, metal, vinyl, and ceramic; fills gaps between materials
Hot-melt glue	Flexible bond; waterproof; applied with a glue gun	Bonds most materials; good for joints that can't be clamped; fills gaps between materials
Mastic (latex- or solvent-base) **construction adhesive**	Water-resistant (some are waterproof)	Different types available for bonding resilient, composition, wood, and ceramic tile; resilient sheet material; paneling; and wallboard; indoor-outdoor types available
Resorcinol glue (marine resin)	Strong, rigid, permanent bond; waterproof; dries dark; mix before use	Good for bonding wood in high-moisture applications (must be clamped); fills tight gaps between materials
Plastic resin glue	Strong bond; water-resistant (but not as water-resistant as resorcinol); mix before use	Use on wood for a structural bond (must be clamped)
Instant glue	Instant, strong bond	Bonds nonporous materials such as metals, glass, porcelain, ceramic, rubber, and most plastics CAUTION: Bonds quickly to skin

Caulks & Sealants

TYPE	CHARACTERISTICS	USES
Elastomers		
Silicone rubber	Long-lasting, elastic seal; waterproof; some paintable	For interior and exterior use on moving joints in metal, glass, masonry, tile, porcelain, and ceramic
Polyurethane sealants	Long-lasting, elastic seal; waterproof; available in colors	Good for sealing cracks and for glazing; adheres to wood, masonry, glass, and metal
Polyurethane foams	Long-lasting seal; expansive foam application	Seals interior and exterior cracks (use with primer on unpainted wood and masonry)
Butyl rubber	Very flexible seal (may shrink); water-resistant; paintable, but messy to apply	Joins like materials inside and outside; bonds well to metals, especially gutters and flashing
Acrylic latex	Flexible seal; paintable; adheres to damp surfaces	Good for narrow interior joints and for nonmoving exterior joints around painted doors and windows
Nonacrylic latex	Not very flexible	Use on stable interior joints only

Roofing & Siding

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31 *Asphalt Shingles*
32 *Wood Shingles & Shakes*
33 *Built-up Roofs & Roll Roofing*
34 *Roof Flashings*
36 *Gutters & Downspouts*
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40 *Siding*
43 *Wood Siding*
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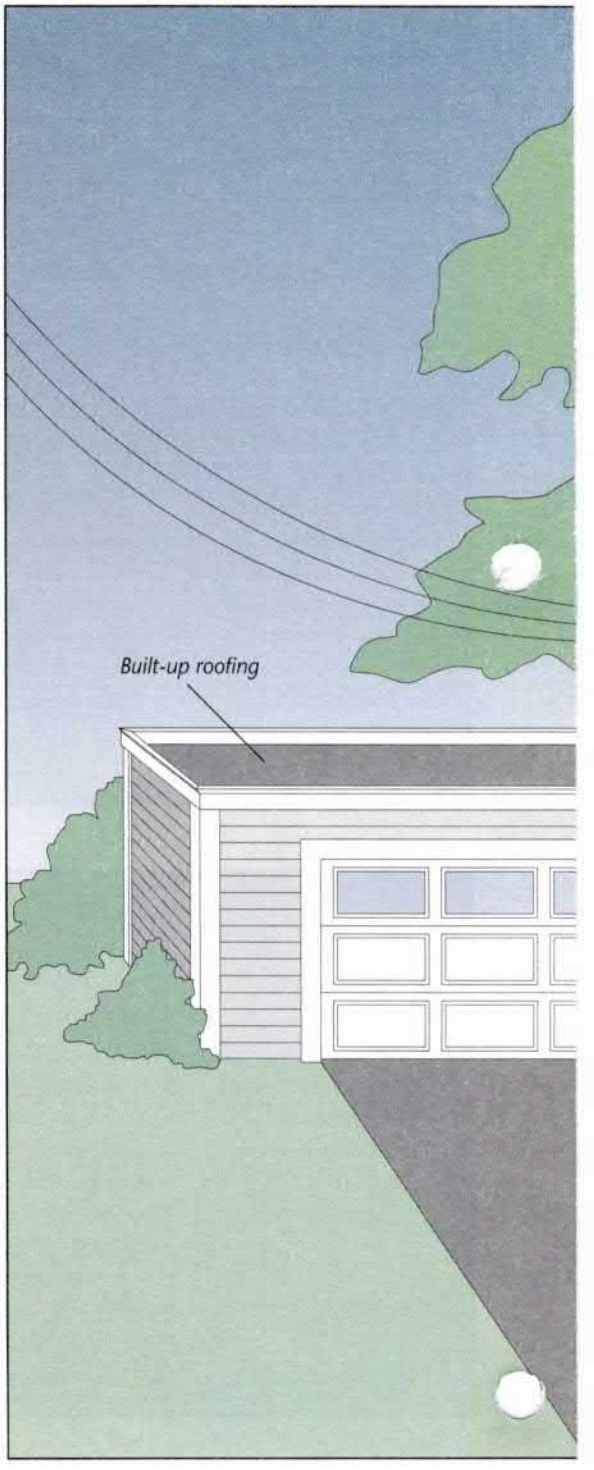
Special Features

30 *Working Safely on the Roof*
37 *Improving Downspout Drainage*
39 *Controlling Ice & Snow on Your Roof*
42 *Solving Exterior Paint Problems*
50 *Controlling Moisture in a Basement*



Protecting your home against the effects of wind, rain, heat, and cold is a tough job requiring tough materials—in this case, a concrete foundation, wood and brick siding, and an asphalt-shingle roof. However, even the best materials will require repairs after being at the mercy of the elements for long periods of time. In this chapter, you'll learn just what steps to take to keep things shipshape.

THE ROOF

Most homeowners wait until something drastic happens to the roof—at which point they have to take immediate action. If you periodically inspect your roof, you can correct minor problems before they become serious enough to cause damage.

Understanding the structure of your roof *(see below)* is the first step toward diagnosing problems. On the facing page, you'll find a guide for inspecting your roof from the inside and outside. If your inspection indicates that repairs are necessary, refer to pages 31-38.

CAUTION: Tile and slate roofs are slippery, and the materials break easily; metal and plastic roofs are also slippery. If your house has one of these out-of-the-ordinary roofs, or the roof is icy or wet, it's best to leave inspection and repairs to a professional roofing contractor.

Understanding Roofing Structure

A roof protects a home—and the people inside—from the elements, especially water and sun. Roofs are designed to shed water; the parts comprising a roof combine to direct water off the roof and away from the house.

ANATOMY OF A ROOF

A typical roof *(see illustration at right)* begins with a framework of rafters that supports a roof deck (sometimes called a subroof) consisting of sheathing and underlayment. The roof deck, in turn, provides a nailing base for the roof surface material.

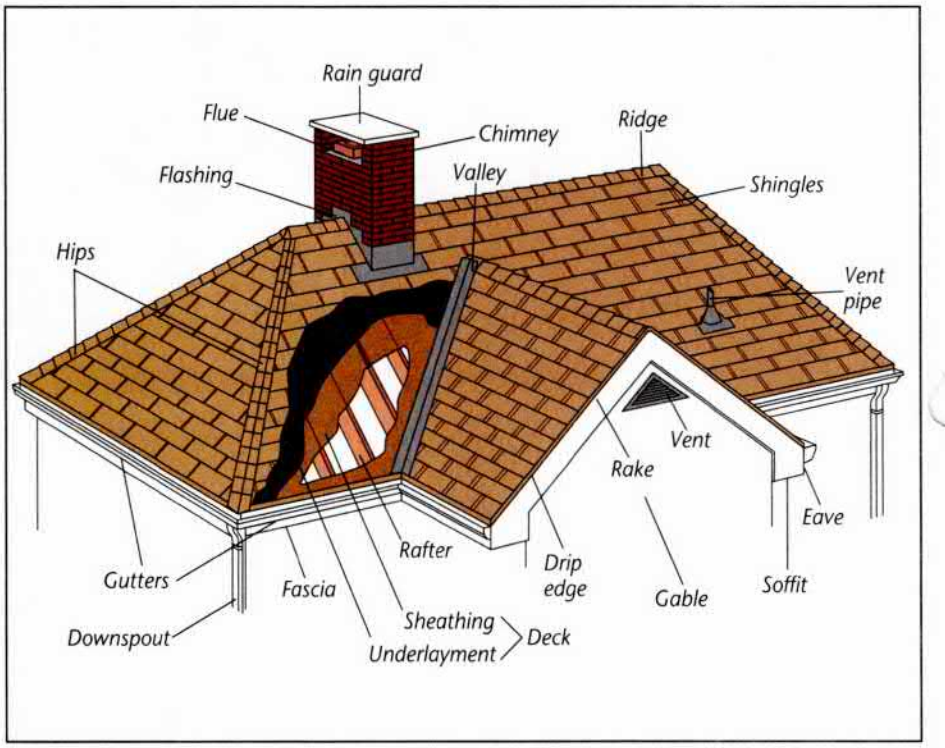
The roof deck. Though the type of roof deck used can vary depending on the roof surface material, most decks have both sheathing and underlayment.

Sheathing, the material that provides the nailing base for the roof surface material, ranges from solid plywood to fiberboard to open sheathing (used with wood shingles).

Sandwiched between the sheathing and the surface material is the underlayment, usually roofing felt. A heavy, fibrous black paper saturated with asphalt, roofing felt is waterproof enough to resist water penetration from outside, yet porous enough to allow moisture from inside the attic to escape.

The roof surface. The material on the roof must be able to withstand wind, rain, snow, hail, and sun and protect the house from these elements. A wide variety of roof surface materials is available—the different types are discussed at right and on pages 31-33.

Anatomy of a roof



The surface of the roof is often broken by angles and protrusions, all of which require weatherproofing—usually provided by flashing. Made from malleable metal or plastic, flashing appears as the drip edge along the eaves of a roof, the collars around ventilation and plumbing pipes, the valleys between two roof planes, and the "steps" along a chimney. Less obvious flashing also protects other breaks in the roof, such as skylights. At the roof edges, gutters catch water runoff and channel it to the ground via the downspouts, which direct water away from the house and into the soil.

TYPES OF ROOFING MATERIALS

Roofing varies widely in size, shape, and material. Traditional sloping roofs are usually covered with overlapping layers of asphalt shingles, wood shingles or shakes, or tile, though you can also use slate, aluminum, or galvanized steel.

Flat or low-sloping roofs are most often surfaced with alternating layers of roofing felt and asphalt or tar, with a layer of gravel on top. These are known as built-up, or tar-and-gravel, roofs. Some flat roofs are covered with insulating polyurethane foam or a rubberlike modified-bitumen membrane.

Inspecting for Damage

It's a good idea to inspect and repair your roof in autumn, before the hard weather hits. Then examine the roof again in spring to assess whatever damage may have occurred during the winter. If you discover problems, make the necessary repairs, following the instructions on pages 31-38.

Inspecting from inside. Begin an inspection in the attic, using a strong flashlight, a thin screwdriver, a knife, and a piece of chalk to examine the ridge beam, rafters, and sheathing. Look for water stains, dark-colored areas of wet wood, moisture, and soft spots that may indicate dry rot. Mark the wet spots with chalk so you can find them easily later on.

If it's necessary to remove insulation batts to examine the sheathing, be sure to wear loose clothing, gloves, goggles, and a respirator for protection.

Next, turn off any lights. If you see any holes above you, drive nails or poke wire through them so they'll be visible from the roof's surface. (In a wood-shingle roof, shafts of light coming in at an angle indicate cracks that may shut when the shingles are wet.)

Inspecting from outside. When you examine the roof from outdoors, evaluate the condition of the roof structure, surface material, flashings, eaves, and gutters.

To check the roof structure, stand back from the house and look at the lines of the ridge and rafters. The ridge line should be perfectly horizontal and the line of the rafters, which you can assess by looking along the plane of each roof section, should be straight. If either sags, call in a professional contractor—your house may have a structural problem.

Next, inspect the roof's surface. Before climbing up on your roof, be sure to read the safety tips on page 30. If you're at all nervous about going up on the roof, make the inspection from a ladder, using a pair of binoculars. Don't walk on the roof any more than is absolutely necessary; you can easily cause more damage.

Inspect the flashings for corrosion and broken seals along the edges. If you have metal gutters and downspouts, look for rust spots and holes.

Then examine the roof surface for signs of wear, loose or broken nails, or curled, broken, or missing shingles.

Use a knife and screwdriver to test the boards along the eaves and rakes. If there is damage caused by dry rot, replace the boards and finish them to match the existing areas.

Locating a Roof Leak

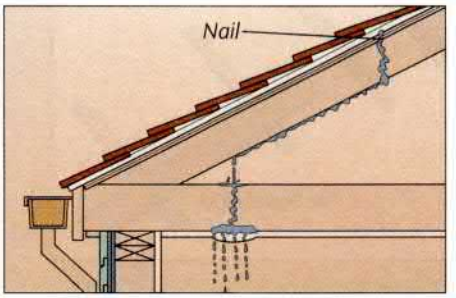
Roof leaks usually appear during storms when you can't make permanent repairs. But you can take steps to temporarily divert or halt the flow of water, as shown in the illustrations below.

Generally, leaks begin at a roof's most vulnerable spots—at flashings, where shingles are damaged, in valleys, or at eaves. The water may show up far from its point of origin after working its way through layers of roofing materials and down rafters to collect in a puddle in the attic or other area of the house.

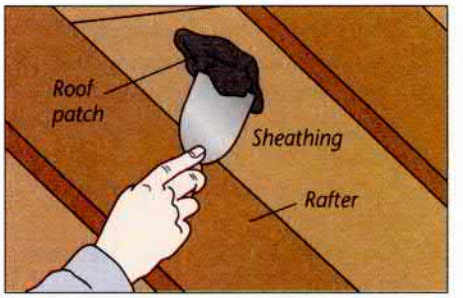
During a storm, trace the course of water to find where it's coming through the roof. Drive a nail or wire through the hole so you can find the hole later when you get up on the roof.

Once the roof is dry enough, look for spots that indicate a source for the leak. Remember, the point where a nail or wire is poking through may be below the actual source. Make permanent repairs as described on pages 31-33.

Temporary repairs for a leaky roof



Water diverter. Drive a nail or poke wire up through the hole to direct some of the water into a bucket directly below; position a second bucket to catch runoff.



Emergency patch. Using a putty knife or caulking gun, apply special roof patch liberally to the hole from inside. Work the compound in thoroughly so it adheres.

Temporary shingle. When the roof is dry, slide a 2-foot square of galvanized sheet metal under the row of shingles above the missing or damaged shingle.

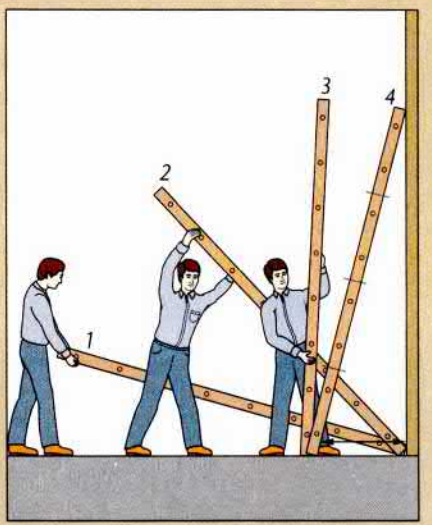
Working Safely on the Roof

Before venturing up a ladder to repair roofing, siding, windows, or gutters, it's important that you know and observe the following safety precautions.

LADDER SAFETY

Ladders for long reaches range from straight wooden types to aluminum extension ladders (one that extends to 20 feet is adequate for most houses). Be sure your ladder is strong, yet light enough to be handled easily. Below are some tips for using a ladder safely:

- Inspect your ladder for cracks and other weaknesses before you lean it against the house.
- Place the base of the ladder on firm, level ground at a measured distance from the side of the house, as shown in the illustration below.
- Get on and off the ladder by stepping onto the center of the rung. Use both hands to grip the ladder rails (not the rungs). Reposition the ladder if it wobbles.
- Keep your hips between the ladder rails. Don't lean out to reach an area; instead, reposition the ladder.



To position a ladder: 1) Set the base against the wall. 2) Walk the ladder into an upright position. 3) Move the base outward. 4) Set the base at a distance from the wall equal to one-quarter the ladder's length.

- Make sure that only one person stands on a ladder at a time.
- Install rubber safety shoes (available at home improvement centers) on the ladder feet if the ladder is to stand on a slick surface.
- Don't stand on the top two rungs of a ladder. If you're repairing a roof, at least two rungs of the ladder should extend above the eaves so you can step directly onto the roof.
- Be sure the rung hooks of an extension ladder are locked in place and that no section is extended more than three-quarters of its length.
- Pull materials up a ladder with a rope and have a place to store them at the top; do not try to carry them up.

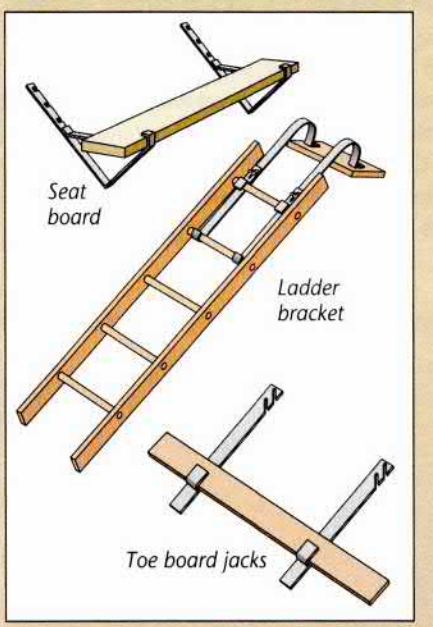
ROOF SAFETY

Working on a roof requires extra caution. The surface is usually slick, sloped, and well above the ground.Below are some precautions to observe when you need to make roof repairs:

- Don't walk on a roof any more than is absolutely necessary; you may cause more damage. Don't walk on tile and slate roofs at all—they're slippery and breakable.
- Let a professional make any repairs on a steeply pitched roof—one that slopes more than 25° or rises more than 4 inches vertically for every 12 horizontal inches.
- Wear loose, comfortable clothing and non-slip rubber-soled shoes with good ankle support.
- Work on the roof only in dry, calm, warm weather. A wet roof can be treacherously slick; a sudden wind can knock you off balance.
- Never work on the roof when lightning threatens.
- Be careful not to put your weight on brittle or old roofing materials and rotted decking.
- Stay well away from power lines and be sure neither your body nor the equipment comes into contact with them. Keep children and pets away.

Special safety equipment. The standard safety devices illustrated below help to distribute your weight evenly and provide secure footing. They're available from tool rental companies. In addition, be sure to check with your local state safety office regarding the laws outlined by OSHA (Occupational Safety & Health Administration); each state has its own safety requirements for roof work.

- A safety harness, used in conjunction with a fall-arrest rope, is an added precaution when working on steep inclines that will keep you from sliding off the roof.
- A metal ladder bracket allows you to hook a ladder over the ridge.
- Nailed to the roof framing, a 2-by-6 plank supports you and your working materials. Use strong, straight-grained lumber no longer than 10 feet unless you support the middle with another jack. The jacks have notches in them so they can be slipped off the nails. When you're finished, set and caulk the nails to avoid leaks.
- An angled seat board lets you sit on a level surface while working.



Safety equipment for working on roofs includes an angled seat board, a metal ladder bracket, and toe board jacks.

ASPHALT SHINGLES

Asphalt shingles are composed of mats made from organic or fiberglass material impregnated with asphalt and embedded with colored mineral granules. Organic-base asphalt shingles, also called composition shingles, have a felt mat made from wood and paper fibers. Fiberglass-base asphalt shingles, commonly called fiberglass shingles, have a fiberglass mat.

Though shapes vary, many asphalt shingles are notched at intervals to form tabs, giving the appearance of smaller units. They usually last from 15 to 25 years, depending on the climate and type of mat. Shingles that are aging may show bald spots; or, you may find a heavy accumulation of granules in the gutters, indicating crumbling shingles.

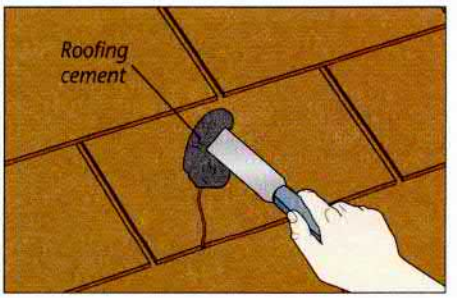
Check your roof's condition on a warm day when the shingles are flexible. Remove a tiny piece of the corner from one or two shingles on each roof plane; the core of the shingle should be black. Gently bend several shingles back to see if they're flexible. If a number of shingles appear gray and bloated, if the material crumbles easily, or if you see large bare spots or damaged areas, consider replacing the roofing.

Cracked, torn, or curled shingles can be repaired, as shown below; replace any loose or missing nails. If some of the shingles are badly worn or damaged, replace them *(see below)*. Use shingles that remain from the original roof installation. If you don't have any leftover shingles, you'll have to buy new ones—identical in brand, color, and size, if possible. Fasten the shingles with galvanized roofing nails that are long enough to penetrate all roofing layers (at least 1½ inches long).

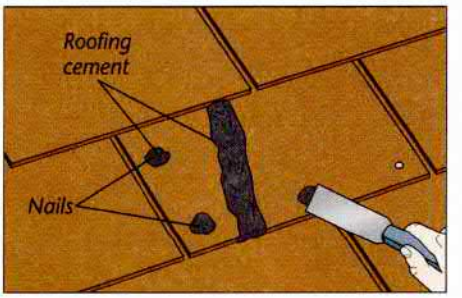
Don't remove a damaged shingle that's on a ridge or along a hip; instead, nail each corner in place. Then apply roofing cement to the bottom of a new shingle and place it over the defective one. Nail each corner, then cover the nail heads with roofing cement.

When you repair asphalt shingles, do the work on a warm day when the shingles are more pliable. Also, have roofing cement at room temperature so it will spread more easily.

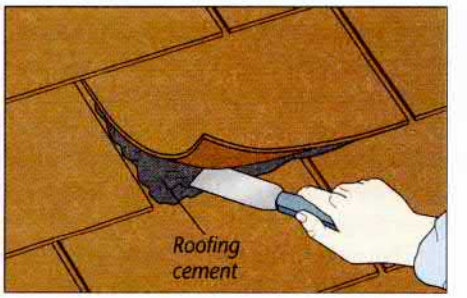
Three shingle repairs



Hairline crack. Seal a very fine crack with roofing cement (or use asphalt paint). Apply the cement or paint along the crack with a putty knife. Cement is also sold in cartridges and can be applied with a caulking gun.



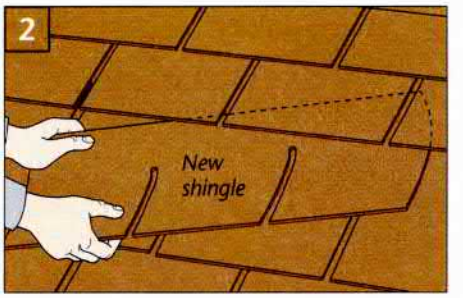
Tear. Liberally trowel roofing cement under the tear. Press the shingle in place; secure each side with roofing nails, covering nails and the tear with roofing cement.



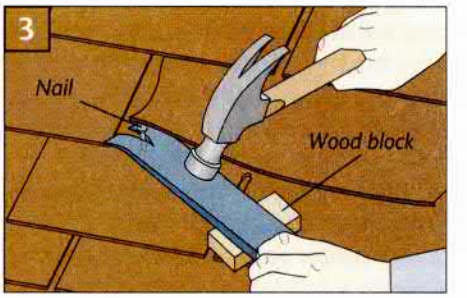
Curled shingle. To flatten a curled shingle, apply roofing cement under the lifted portion; press in place. Tack with roofing nails and cover nail heads with roofing cement.

Replacing an asphalt shingle

Lift the shingle tab above the damaged one and, with a prybar, pry out both rows of nails holding the damaged shingle.



Slide the new shingle into place, taking care not to damage the roofing felt (snip the top corners if the shingle sticks).



Nail on the new shingle; if you can't lift the tab above it high enough to nail underneath, use a prybar as shown.

WOOD SHINGLES & SHAKES

Wood shingles have a smooth, finished appearance; wood shakes have a rough-hewn look. Both are made from western red cedar. Shingles are sawn into lengths of 16, 18, or 24 inches. Shakes, thicker than shingles, are split by machine or by hand into 18- or 24-inch lengths. Both come in random widths.

Shingles and shakes are laid in overlapping rows. Shingles either have a continuous underlayment of roofing felt or none at all; shakes alternate with strips of felt. Both shingles and shakes may be laid directly on the sheathing, or an earlier roofing material and are attached with galvanized roofing nails.

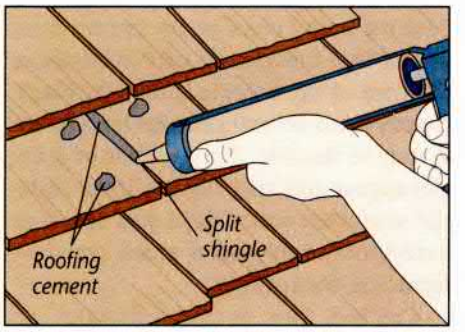
Wood shingles and shakes usually last between 15 and 25 years, depending on the slope of the roof and the climate. If you suspect wear, inspect the roof for curled, broken, or split shingles, and for shingles that have been lifted by wind. Look also for shingles thinned by weathering and erosion, especially around areas where an attic inspection reveals pinpoints of light *(page 29)*. Wood shakes show their age when the wood crumbles easily underfoot or between your fingers.

The extent of the defects you find will indicate whether you can repair or need to replace shingles or shakes. If only a few shingles or shakes are split or wind-lifted, you can repair them; those that are badly splintered or curled should be replaced *(see at right)*. If the damage is extensive, consider replacing the entire roof.

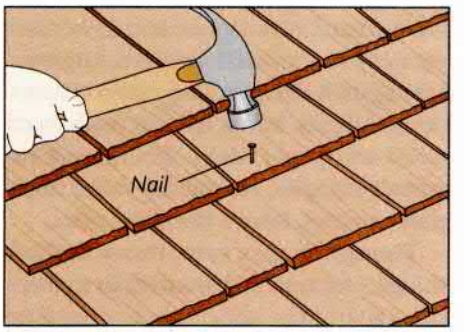
To remove the nails from a damaged shingle or shake you're replacing, either rent a shingle ripper to cut them or use a hacksaw blade. To use the ripper, slide it under the shingle and around a nail; then cut the shank of the nail with a hammer blow *(see Step 2 at right)*.

Since shingles and shakes are of random widths, you'll likely need to trim the new ones to fit the space. Use a roofer's hatchet or a saw. Leave a ¼-inch clearance on each side of every replacement piece to allow for expansion of the wood.

Repairing a wood shingle or shake



Split shingle. Butt the pieces together, drill pilot holes, and nail in place. Cover nail heads and joint with roofing cement, using a caulking gun or putty knife.

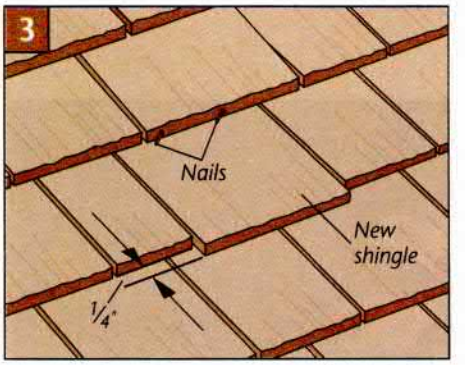


Wind-lifted shingle. Press the shingle down and secure it with galvanized roofing nails. Daub roofing cement over the nail heads to seal them.

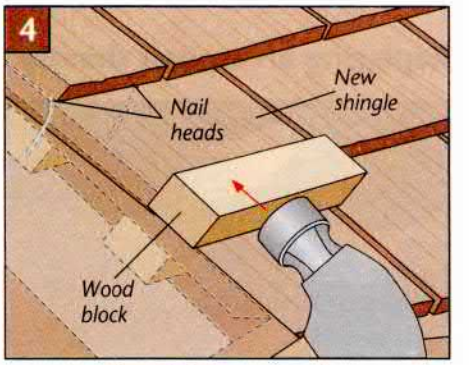
Replacing a wood shingle or shake

Carefully split the damaged shingle along the grain and pull out as much of it as possible. Pry up the shingles directly above the damaged one to reach nails securing it.

Cut the nails securing the shingle to the roof deck, using a shingle ripper as shown (or saw nails off with a hacksaw blade). Don't damage the sheathing or underlayment.



Insert the shingle so it protrudes 1/4 inch below adjoining shingles; allow 1/4 inch clearance on each side. Drive in two roofing nails at an angle just below the edge of the row above.



Drive the edge of the new shingle even with the other shingles, using a hammer and wood block. The nails will bend, pulling the heads under the shingles above.

BUILT-UP ROOFS & ROLL ROOFING

Homes with flat or low-sloping roofs usually have a built-up roof surface, also called a tar-and-gravel roof. Sheds and garages are sometimes roofed with asphalt roll roofing.

A built-up roof consists of several layers of roofing felt, each coated with hot- or cold-mopped asphalt. The top layer is crushed gravel or rock that protects the asphalt from ultraviolet light. These roofs generally last from 10 to 20 years, depending on the climate.

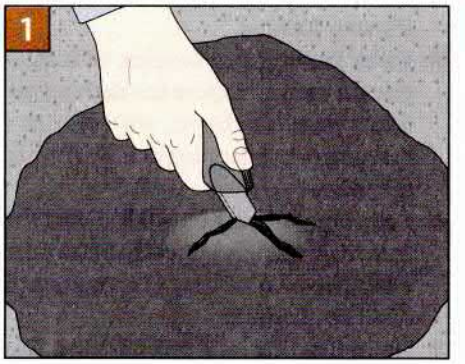
Asphalt roll roofing generally has a lifetime of 5 to 15 years and is commonly used to cover the valleys of an asphalt-shingle roof.

Leaks in a flat roof are almost always easy to locate—they tend to be directly above the wet area on the ceiling below. Leaks may develop at flashings *(page 34)* or where wind has blown the gravel away to leave the surface exposed. Leaks are also likely where weather and wear have caused blistered asphalt, separations between the roof surface and the drip edge, curling or split roofing felt that's exposed, and cracks or holes in the roof material.

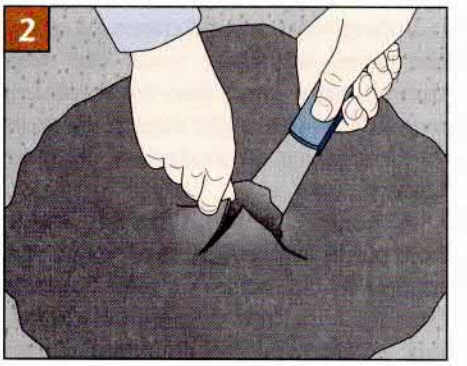
Repairs are the same for both built-up and roll roofing. Fill in any cracks with roofing cement. If you're repairing a blister or small hole *(see at right)*, insert roofing cement inside the sliced blister or under the hole, cut the patch you need from either a piece of roll roofing or an asphalt shingle, and insert the patch into the hole. Cover the area with a liberal coating of roofing cement. For holes larger than a square foot, call a professional roofer. Avoid using nails when repairing blisters and small holes in built-up roofs of roll roofing. Driving a series of nails may, in fact, cause additional leaks.

If your roof is beyond repair and needs to be replaced, it's a good idea to call in a professional roofer. Resurfacing a flat roof with layers of roofing felt and hot-mopped asphalt is beyond the scope of the vast majority of homeowners because of the processes and equipment involved; moreover, it can be a messy and dangerous job.

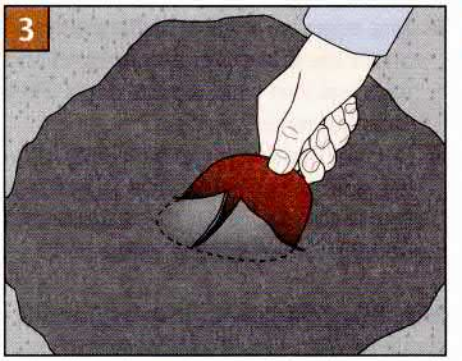
Repairing a blister or hole



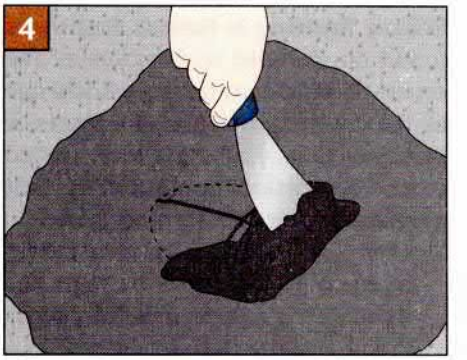
Sweep all gravel aside, using a stiff-bristled broom. Then, with a utility knife, cut into the asphalt and roofing felt until the pressure under the blister is released.



Insert a generous amount of roofing cement inside the lacerated blister or hole, applying it with a putty knife. Work the cement well under each edge of the cut.

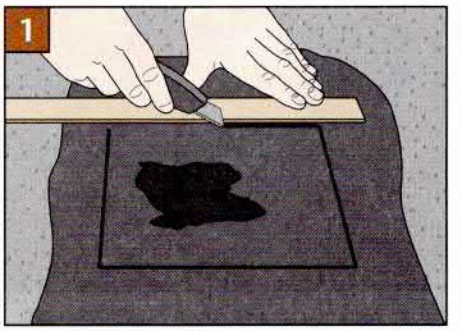


Cut a patch 2 inches larger on all sides than the slit or hole. Press it into the roofing cement, making certain to cover as much of the area inside the cut as possible.

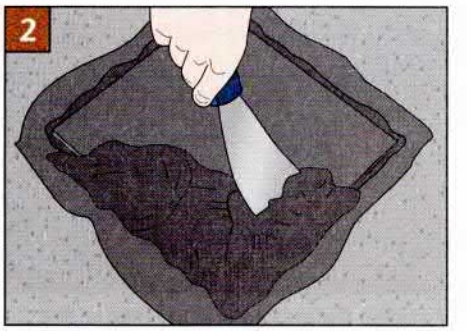


Cover the blister or hole with roofing cement to seal the patch, working the cement about 2 inches beyond the edges. Replace gravel as cement begins to dry.

Patching a hole



Sweep all gravel aside, using a stiff-bristled brush. Cut out a rectangle around the damaged layers of roofing. Remove the pieces, then cut a patch to fit the rectangle exactly.



Fill the hole with roofing cement and place the patch on the cut-out area. Apply more cement, extending beyond the patch edges. Replace gravel as cement begins to dry.

ROOF FLASHINGS

Flashing protects the roof at its most vulnerable points: in the valleys, at roof and plumbing vents, around chimneys, along the eaves—anywhere water can seep through open joints into the sheathing *(page 28)*. As you might expect, the areas where flashings are located are the most prone to leaks.

Although you'll find flashings made from plastic, roll roofing, roofing felt, and rubber, the best choice for most homes is flashing made from rust-resistant metal, such as galvanized steel, aluminum or copper. The flashing joints may be sealed with roofing cement or caulking *(for tips on caulking, see page 49)*. Cracked or crumbling cement or caulking is a major cause of leaks around flashings.

Where flashing is found. Flashing is found on shingled roofs wherever the courses of shingles are interrupted, whether by the intersection of two roof planes or by obstructions. Flashing is also installed around obstructions or protrusions (such as vent pipes) on built-up roofs *(page 33)*.

- Chimney flashing is installed in two layers to protect joints between the chimney and roof. Step flashing bends in an L shape to fit along the roof deck and up the sides of the chimney, and is interleaved with the shingles. Cap or counter flashing is mortared or caulked into the chimney and bends down over the step flashing.
- Valley flashing may be open, with shingles cut away to expose the flashing *(see facing page)* or closed, with shingles meeting or overlapping at the center of the valley.
- Vent-pipe flashing is installed over the course of shingles directly below the pipe. The next courses of shingles will cover the flashing.
- Skylights that are self-flashing *(see facing page)* have built-in flanges that sit on the roof deck. A skylight mounted on a curb (a wood frame attached to the roof deck) requires flashing, much like that for chimneys, installed all around the curb.
- Drip edges are strips of flashing installed under the shingles along the eaves and rakes and over windows and doors. They facilitate water runoff.
- Dormer flashing is similar to step flashing found on chimneys; it extends under the siding on the dormer and under the roof shingles at the base.

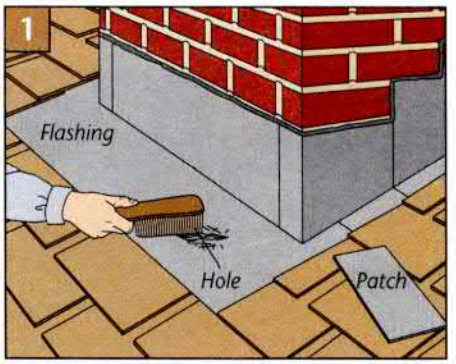
Repairing flashings. Inspect flashings semiannually. Renail any loose nails and cover all exposed nail heads with roofing cement. Look carefully for holes. You can plug pinholes with spots of roofing cement; patch holes up to about 3/4 inch in diameter with the same material as the damaged flashing *(see below)*. Replace the flashing if you find larger holes.

Check the all-important seals at the flashings' edges. If the roofing cement or caulking is cracked, dried, or crumbling, reseal the joints promptly (directions for the most common types of flashing appear on the facing page).

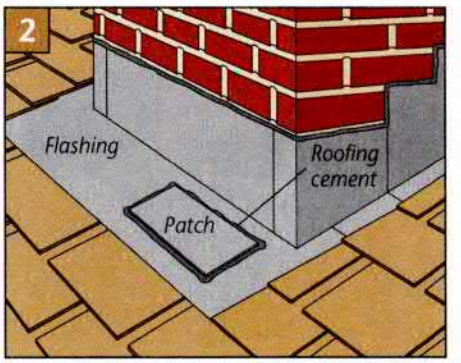
Repainting a flashing. To make the flashing less conspicuous, it's often painted to match the roof. Before repainting, use a stiff brush and solvent to remove any flaking paint, rust, or corrosion from the flashing (keep solvent off asphalt shingles; it will dissolve them). Tape newspaper to the roof around the flashing. Apply a zinc-base primer, then spray on two or more light coats of rust-inhibiting metal paint.

Replacing a flashing. You'll need to replace any flashing that has large holes or is badly corroded. You can buy new flashing or cut it out of aluminum or copper (use the old flashing as a pattern). To install new flashing, several courses of shingles as well as the flashing itself have to be removed. If you have no roofing experience, you may want to hire a professional.

Patching a hole in flashing



Roughen the area around the hole with a wire brush or sandpaper, then clean the surface. Cut a patch of flashing material 2 inches larger than the hole on all sides.



Apply roofing cement, then press the patch in place and hold it for several minutes. Cover the patch with another generous layer of cement.

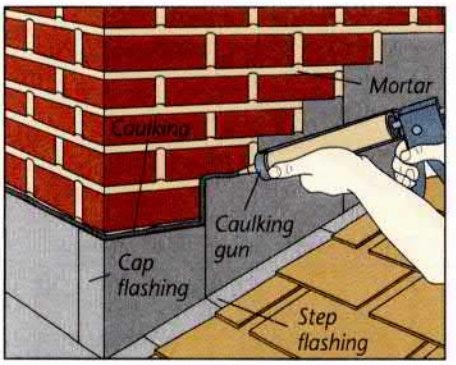
PROFESSIONAL TIPS

REMOVING ROOFING CEMENT

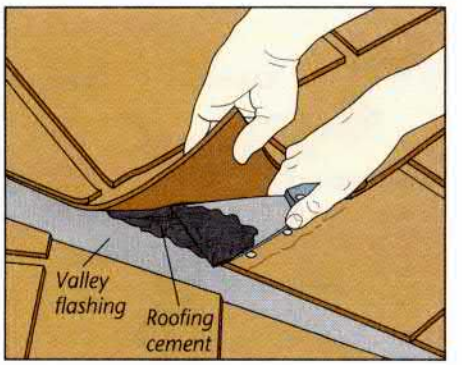
Roofing cement works wonders on a roof, but when it gets all over you and the roof, it can create an undesirable mess.

Fortunately, roofing cement can be removed with relative ease. Use a rag moistened with kerosene to scrub unwanted cement from both the roof and you. Promptly wash any kerosene from your skin and dispose of the rag properly.

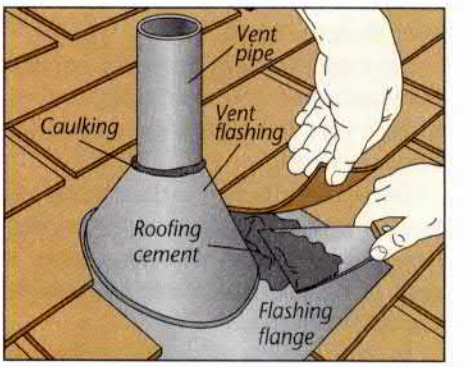
Renewing flashing seals



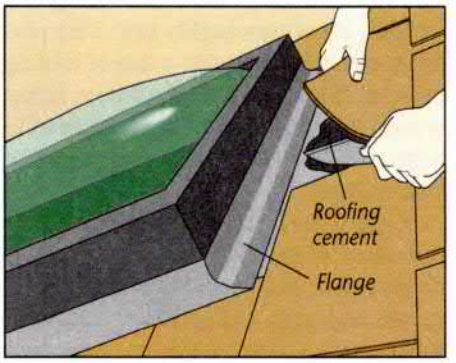
Chimney flashing. Chip out the old mortar and caulking along the cap flashing. Caulk the joints between the flashing and chimney and between the cap and step flashings.



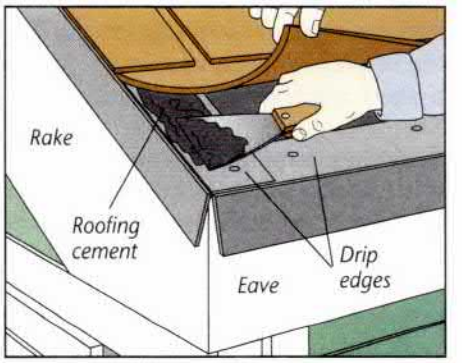
Valley flashing. Lift the edges of the shingles along the flashing and spread roofing cement on the flashing to about 6 inches in from the edges of the shingles.



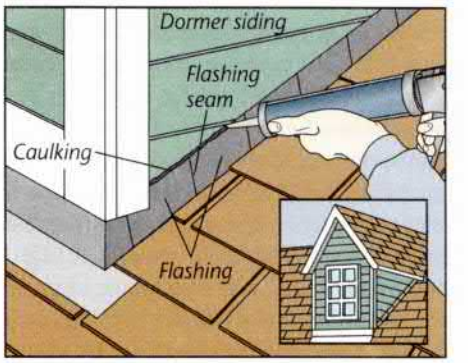
Vent-pipe flashing. Caulk the joint between the flashing and pipe. Lift the side and back shingles; apply roofing cement to the joints between the flange and shingles.



Self-flashing skylight. Lift the adjacent shingles and spread roofing cement liberally on the joints between the skylight flange and roofing felt.

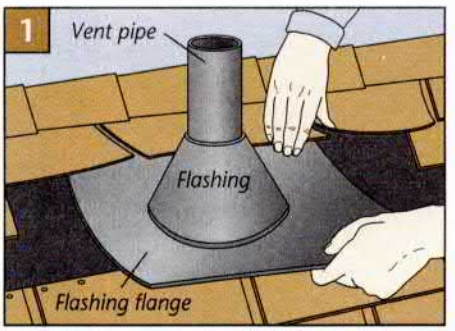


Drip edge along a gable rake. Lift the shingles and spread roofing cement on the top of the drip edge. Don't seal the drip edge along the eaves.

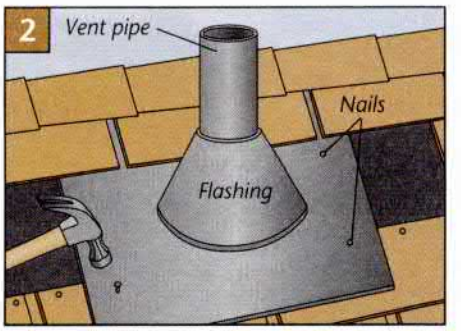


Dormer flashing. Remove any old caulking; apply caulking to the joints between the flashing and siding or shingles and between flashing seams.

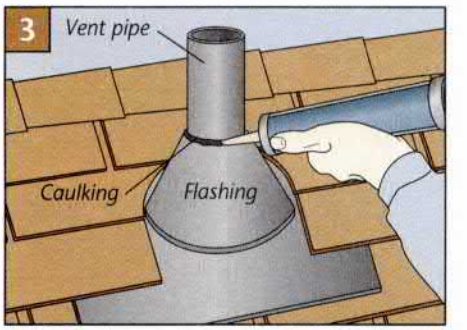
Replacing vent-pipe flashing



Remove the shingles covering the flange at the back and sides. Using a hacksaw blade or shingle ripper, cut off the nails holding the flashing in place; lift the flashing off.



Position the new flashing over the vent pipe and secure it with nails. Be sure to place the nails so the replacement shingles at the back and sides will cover the nail heads.



Replace the shingles *(pages 31-32)*, covering the nail heads and flashing joints thoroughly with roofing cement. Caulk the joint between the flashing and vent pipe.

GUTTERS & DOWNSPOUTS

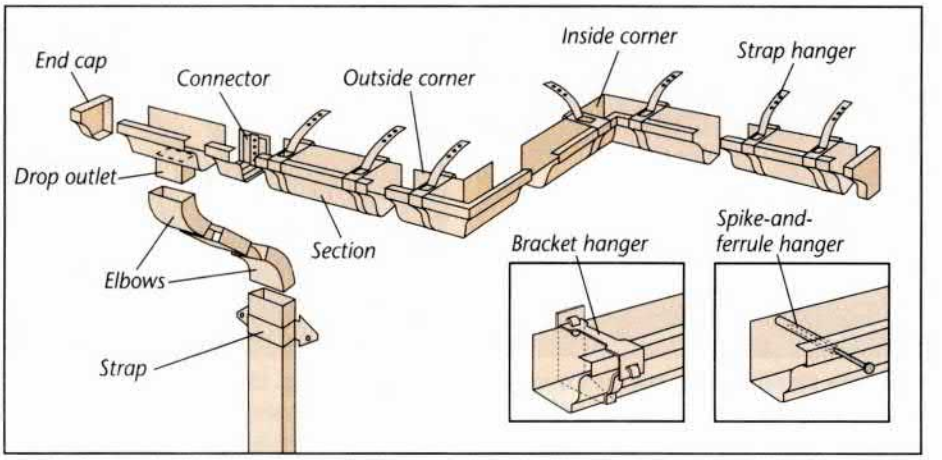
A roof sheds water, but it's the gutter and downspout system that carries the water away from the house.

Most gutters and downspouts are made from galvanized steel, aluminum, or vinyl, though you may find some made from wood or copper.

Gutters are attached to the eaves of the house with strap, bracket, or, most commonly, spike-and-ferrule hangers *(see at right)*. Downspouts are attached to the exterior walls with straps.

In order to work efficiently, gutters and downspouts must be in good condition, must be sloped properly, and must be free of leaves and other debris.

A typical gutter system



Gutter and downspout maintenance. Regular inspection and maintenance are crucial for keeping your gutters and downspouts in good working order. Inspect them in the autumn and spring, and clean out accumulated leaves and other debris, as shown below. Then check the slope of the gutters by running water through them. If drainage is slow, reposition the gutters for the correct slope: they should be tight against the fascias and should slope toward the downspouts at a rate of 1 inch for every 20 feet. You can correct low spots by adjusting the hangers. For appearance, many gutters are hung horizontally level, these need more frequent downspouts.

Test for weaknesses in gutters, downspouts, and fascia boards by probing with a thin screwdriver or knife. Also, look for flaking or peeling paint, rust spots, broken hangers, and holes or leaky joints.

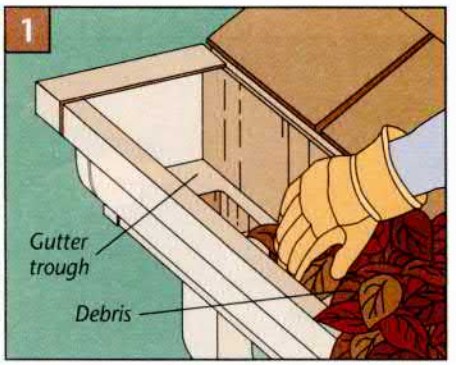
Repairing gutters and downspouts. If you find dry-rotted fascia boards, repair them first. Carve out bad spots and fill them with wood putty or replace the damaged section with a piece of well-seasoned lumber (apply a wood preservative first), then finish to match the existing boards.

Tighten loose hangers and replace broken ones. Check that downspout straps are secure and that elbow connections are tight.

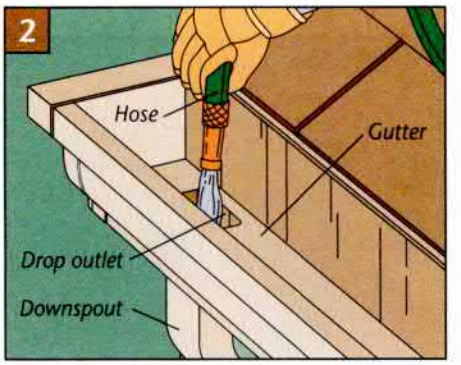
Patch any leaking joints or obvious holes in the gutters *(see facing page)*, taking care to clean them thoroughly first. Tiny pinholes can be sealed with a dab of roofing cement. If a whole section of your gutter system is badly damaged, you will need to replace it (for professional help, check the Yellow Pages).

Repaint the inside of wooden gutters as necessary with asphalt roof paint. Sand down rusted and corroded areas of metal gutters and apply asphalt aluminum paint to the inside. Use a rust-inhibiting zinc-base primer on the outside. Then paint the outside of wood or metal gutters to match the house exterior.

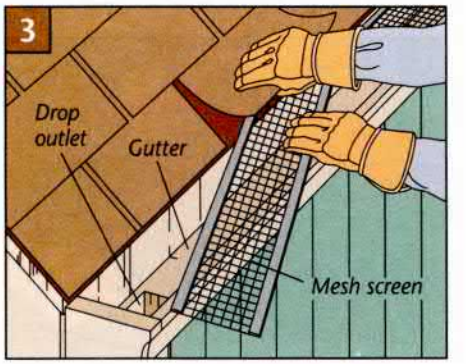
Unclogging gutters and downspouts



Remove leaves, twigs, and other debris from gutter troughs (protect your hands with gloves). Loosen dirt with a stiff brush; hose all debris out of the system.

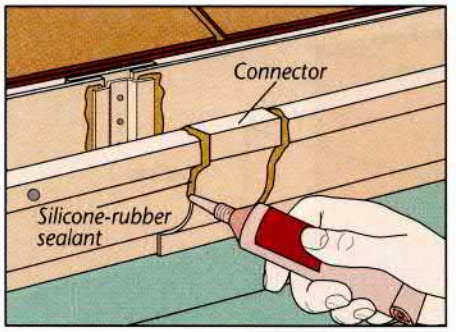


Clean a blocked downspout by spraying with a garden hose turned on full force. Or, feed a plumber's snake into it and then flush all loosened debris out with a hose.

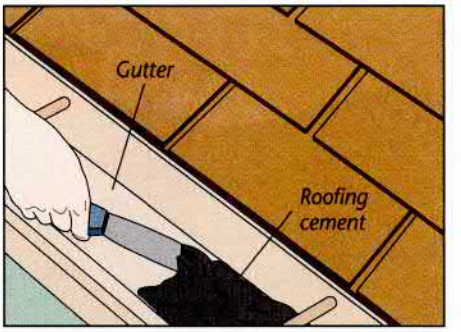


Add mesh screens to deflect leaves, twigs, and other debris over the edge of the gutter. A leaf strainer (not shown) will admit water and filter out debris.

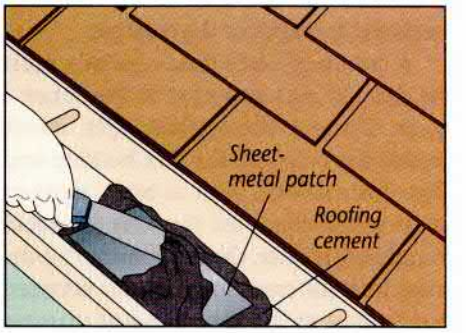
Three gutter repairs



Leaky joint. Apply silicone-rubber sealant or butyl-rubber caulking to seal around the seams between sections on the inside and outside of the gutter.



Small hole. Using a putty knife, patch with a thin coat of roofing cement, spreading the cement and extending it beyond the hole in all directions.



Hole larger than 1/2 inch. Cover with roofing cement and embed a sheet-metal patch in the cement. Apply another coat of cement over the patch.

Improving Downspout Drainage

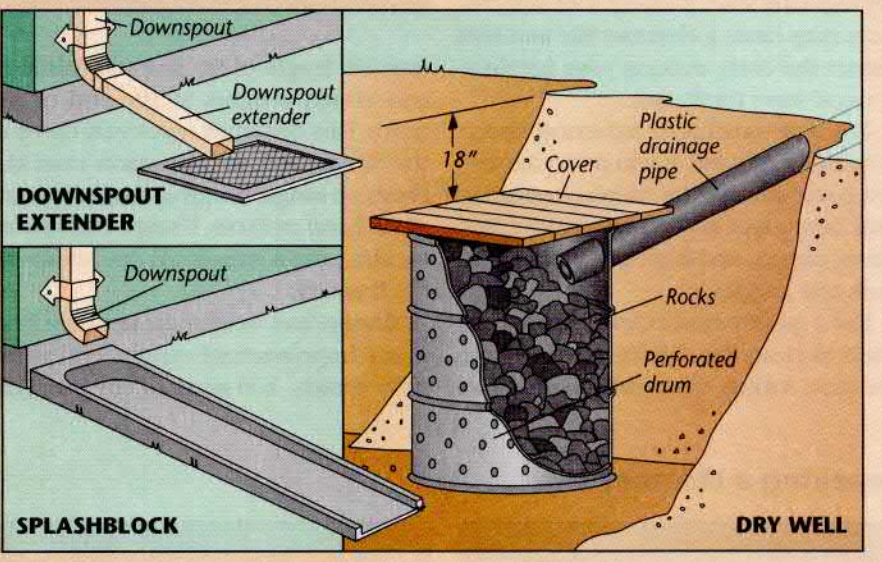
Water that's allowed to flow from your downspouts directly into the ground may end up in your crawl space or basement and can erode the soil alongside the house, causing settling of the structure.

To divert water away from the house, you can use splashblocks, flexible plastic sleeves attached to the downspouts, or plastic drainage pipes that carry water to a dry well located several yards from the house.

Splashblocks. Place a ready-made concrete or plastic splashblock below an elbow that is attached directly to the downspout. Ideally, the splashblock should extend at least 4 feet and should be slightly sloped so that the water flows well beyond the house foundation.

Downspout extenders. An alternative to a splashblock is an extender that you attach directly to the downspout. Extenders are made from galvanized steel, aluminum, or vinyl. They are designed to carry the water away from the house, often into a drain as shown at right. Downspout extenders can be purchased in home improvement centers.

Three drainage devices



Dry wells. If you live in a wet climate, you may want to link your downspouts to a dry well (check local building codes and property lines before installing one).

Locate the dry well 10 or more feet from the foundation. The well itself can be simply a hole 2 to 4 feet wide and 3 feet deep; or you can bury a 55-gallon drum after puncturing it with holes and removing both ends. Fill the well with rocks or broken concrete blocks; cover the top with wood slats or heavy roofing paper. The well's top should be at least 18 inches below ground level; the bottom should be above the water table.

Underground drainage pipes, sloped 1/4 to 1/2 inch per foot, carry water from the house downspouts to the dry well.

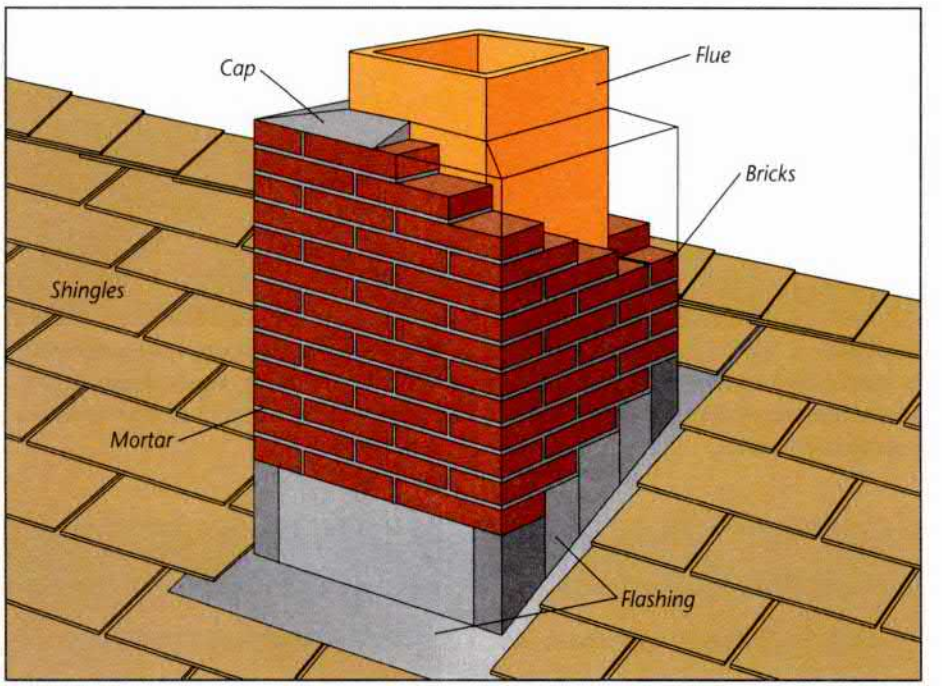
CHIMNEYS

Most chimneys are built of brick and lined with fireproof flue tiles. A cap of mortar seals the top against the weather.

A chimney that's used regularly must be cleaned and inspected at least once a year. Using a strong flashlight, check inside the chimney for soot buildup and any obstructions, such as birds' nests or leaves. Also check the flue tiles for cracks or missing mortar. On the chimney's exterior, look for crumbling mortar between bricks and at the cap, loose or missing bricks, or flashing that has corroded or pulled away from the chimney; all can cause chimney leaks.

To clean the chimney or make minor repairs, see below. If the chimney is leaning, if a number of bricks are missing, or if the flue needs repair, you should consult a professional.

Anatomy of a chimney



Cleaning a chimney. Clean your chimney regularly since built-up soot and creosote may cause a chimney fire and will restrict the draft, making your fireplace or wood stove inefficient.

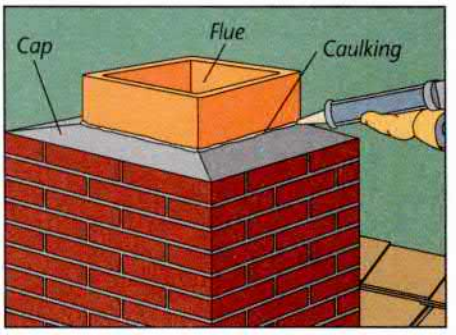
You may want to hire a chimney sweep to do this messy job. If you do it yourself, first cover the interior fireplace opening with newspaper and protect nearby furniture, carpets, and draperies. Wear a dust mask and goggles.

Use a quality steel chimney-sweeping brush to clean the chimney from up on the roof. Attach the brush to a rope at least the length of the flue and chimney, and attach weights to the end of the brush. Pass the brush repeatedly down to the flue bottom and up again until the brush no longer brings up large amounts of soot and creosote. Using a heavy-duty vacuum, not a household one, clean out the fireplace.

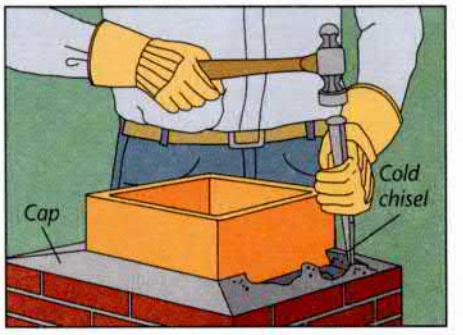
Brushes and weights are available from home improvement centers and wood stove dealers. You also can buy fiberglass rods that attach to the brush; they're useful for cleaning long horizontal runs of stovepipe or for cleaning out a chimney from below.

Repairing a chimney. To repair a cracked or crumbling cap, see the illustrations below. Replace mortar around chimney bricks as you would for brick veneer *(page 47)*. For instructions on making repairs to chimney flashing, see page 35.

Repairing a chimney cap



Minor cracks. Caulk all joints and any cracks in the cap; seal the joint between the flue and the cap with caulking.



Crumbling cap. Chip out the old mortar and rebuild the cap with new mortar, sloping the cap away from the flue.

PROFESSIONAL TIPS

MAKING CHIMNEY IMPROVEMENTS

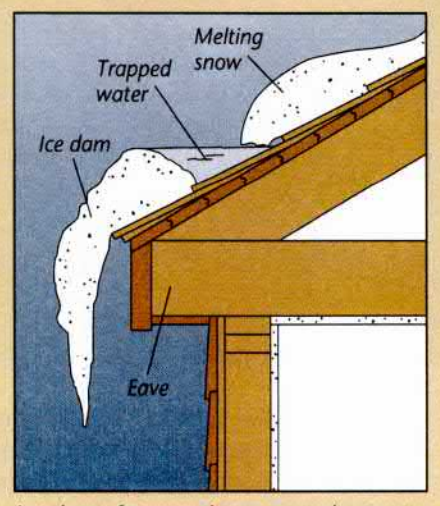
You can install mesh spark arresters to prevent sparks and embers from flying out of the chimney and starting a fire, and to discourage birds from entering. Rain guards and draft deflectors deflect flying embers, rain, and drafts. Look for these at home improvement centers.

Controlling Ice & Snow on Your Roof

Winter storms can wreak havoc on your roof. Ice dams that form at the eaves can result in leaks, snow can melt and slide off the roof in a mini-avalanche, carrying roofing material and gutters with it. You can prevent most problems by keeping the attic cold, with efficient air sealing of the attic floor and well-placed vents to draw out any heat that does escape from the house.

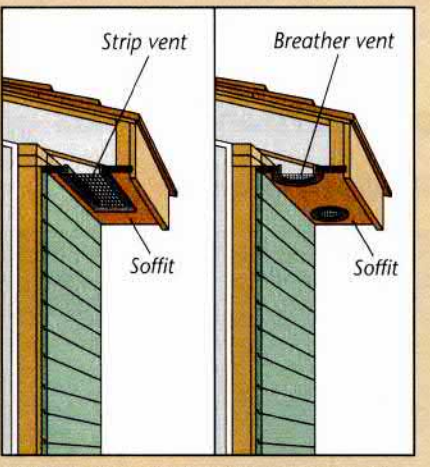
ICE DAMS

These dangerous dams *(see illustration below)* form at the eaves and can cause water from melting snow to back up under the shingles and leak into the house. Ice dams can result from alternate thawing and freezing of snow on the roof due to a period of warm days and cold nights, or from heat loss through the roof of a poorly insulated and badly ventilated house, causing the snow to melt and then, in cold weather, freeze again at the colder eave area.



Ice dams form at the eaves, where repeated thawing and freezing occur.

Air sealing. Your best defense against ice dams on the roof is to seal off all the places where air can leak into the attic from the house. To determine whether moisture problems are generated by interior or exterior sources, check the attic during or just after a rain storm. If there are no water leaks, check around all light fixtures that penetrate the attic floor and around ducts, plumbing stacks, and attic hatches. If light comes through joints or you feel a draft, use caulking or weatherstripping to seal the spaces and create a solid air barrier.



Soffit vents permit warm air to escape from the attic.

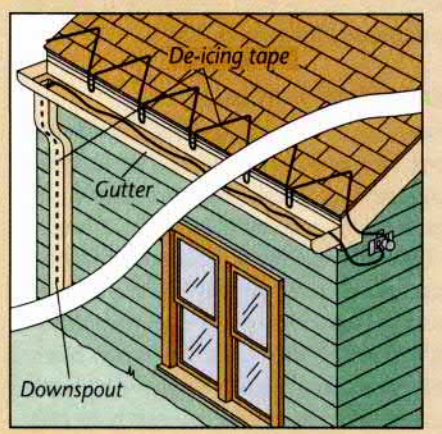
Soffit vents. These are your second line of defense against attic moisture and work most efficiently when all air leakage problems are corrected. To prevent ice dams resulting from poor ventilation, install soffit vents *(see above)* and gable vents. Used in conjunction with one another, they vent warm attic air that might otherwise melt snow on the roof and cause ice dams. Electric exhaust fans actually pull warm air from the house and cause damage; avoid them.

Insulation. More insulation means a colder, less moist attic. Make sure that your insulation is distributed evenly and that there is full-depth coverage. If any of the insulation is damp, repair the source of the leak and then replace the insulation. Insulation should never touch the roof or block vents.

Eave reinforcement. For extra protection on a section of roof where ice dams often form, you can reinforce the eave area by installing a sheet of roll roofing or a rubberlike membrane under the shingles so it extends 12 inches inside the wall line. (This is best done when a new roof is being installed; if you're not reroofing, you'll have to replace several courses of shingles.)

SNOW BUILDUP

Snow tends to slide off roofs like an avalanche, tearing gutters from their fastenings, ripping away roofing materials, and smashing plants or objects below. Below are two suggestions for handling the problem of snow buildup on your roof.



De-icing tapes, when heated, create drainage channels for water.

De-icing tapes. Electrically heated cables installed along roof eaves and in gutters and downspouts, de-icing tapes *(shown above)* facilitate proper drainage of melting snow and ice, and help to prevent ice dams.

These tapes, insulated for safety, are clipped to the shingles in a zigzag pattern (or run along gutters and inside downspouts) and are plugged into a weatherproof electrical outlet. When heated, they create drainage channels for water that otherwise would back up behind an ice dam or freeze inside the gutters and downspouts.

Snow guards. To help hold snow in place, attach metal snow guards in staggered rows along the roof. You'll find several styles, including long, narrow ones for use over doorways.

SIDING

Whether it's wood, vinyl, aluminum, steel, masonry, stucco, or composite materials, the exterior wall covering on your house is called siding. In addition to its decorative role, siding gives strength to exterior walls and ultraviolet-radiation protection for the inner walls, and acts as a barrier, protecting your house from the elements.

Siding may be plagued by a variety of ills, from obvious problems like peeling paint to less obvious insect infestation and dry rot. Many problems can be remedied if caught early on; regular inspection and maintenance are crucial *(see pages 42-49)*. More modern cement-based composite sidings require little or no maintenance and should be a consideration if you are replacing siding.

Understanding Siding

Siding comprises only one layer of the exterior wall of a house. It's important to understand the entire wall structure if you're repairing or replacing siding.

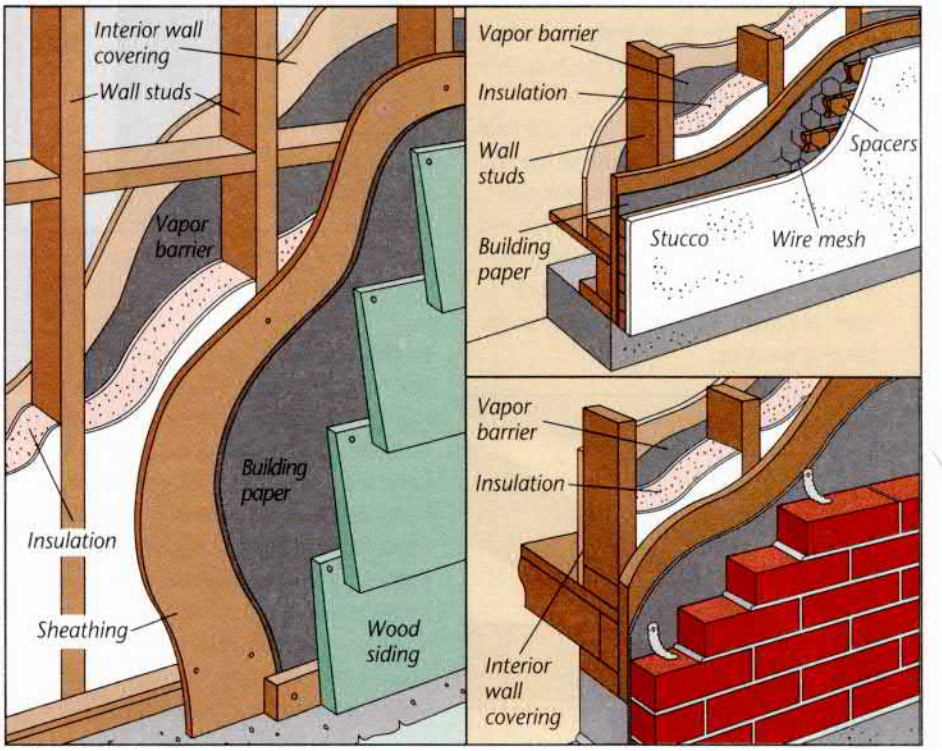
ANATOMY OF A WALL

Wood frame walls are usually constructed from 2-by-6 or 2-by-4 studs *(see at right)*. Insulation is placed between the studs, which are then covered with sheathing.

If the walls are to be finished with wood, aluminum, steel, or vinyl siding or with masonry veneer or composite, the sheathing is covered with building paper. Many walls provide a vented air space between the building paper and the siding to help keep the wall dry. Then the siding is nailed on or, for masonry walls, a veneer of brick or stone is applied. Each course, or tier, of bricks or stones is attached to the underlayment with short metal strips called ties. The bricks or stones are mortared in place.

For stucco siding, wire mesh is nailed directly to sheathing covered with building paper, or the mesh is nailed to spacer strips as shown at right. The stucco is applied over the wire mesh in three layers.

Anatomy of a wall



TYPES OF SIDING

Residential siding generally falls into one of three categories: wood, masonry, or manufactured. Each has its own particular problems; repair and replacement methods depend on the type of siding you have. If you need to replace damaged siding, note the style, finish, and dimensions of the existing siding so you can find an exact match.

Wood siding. This category includes plywood and board siding as well as shingles and shakes. Board siding, available in many types of wood and milled in a variety of patterns *(page 44)*, can be installed vertically, horizontally, or even diagonally. Shingles and shakes are also available in a number of patterns. Plywood is cheaper than other wood siding, and comes in variety of patterns and surface textures. With regular maintenance, wood siding should last from 30 years to the life of the house.

Masonry siding. Grouped under masonry siding are stucco, brick, and stone. Stucco is a cement-based plaster. It can be bought premixed and colored. The finish coat can be tooled in a number of textures. Brick walls may be laid in one of several patterns; the bricks come in a wide range of sizes, colors, and textures. Stone veneer can also be laid in a variety of patterns. Mortar—a mixture of cement, sand, lime, and water—holds the bricks or stones together. Masonry siding is practically impervious to weather and should last the life of the house.

Manufactured siding. Aluminum, steel, vinyl, and cement-based composite siding panels are applied either horizontally or vertically; they usually come with trim pieces into which panels are fitted. They are available in a range of colors and textures. Depending on exposure to elements and maintenance, these types last from 20 years to the life of the house.

Inspecting & Maintaining Siding

With routine maintenance, your siding should last for years. To keep your house looking its best, inspect your siding for damage in the spring and autumn, make any needed repairs promptly, and clean and repaint regularly.

Inspecting your siding. Look for obvious problems such as warped boards, missing or damaged shingles, holes in stucco, crumbling mortar, cracks, and defective paint. Don't ignore less obvious interior problems such as dry rot and termite damage; these can eventually destroy your house.

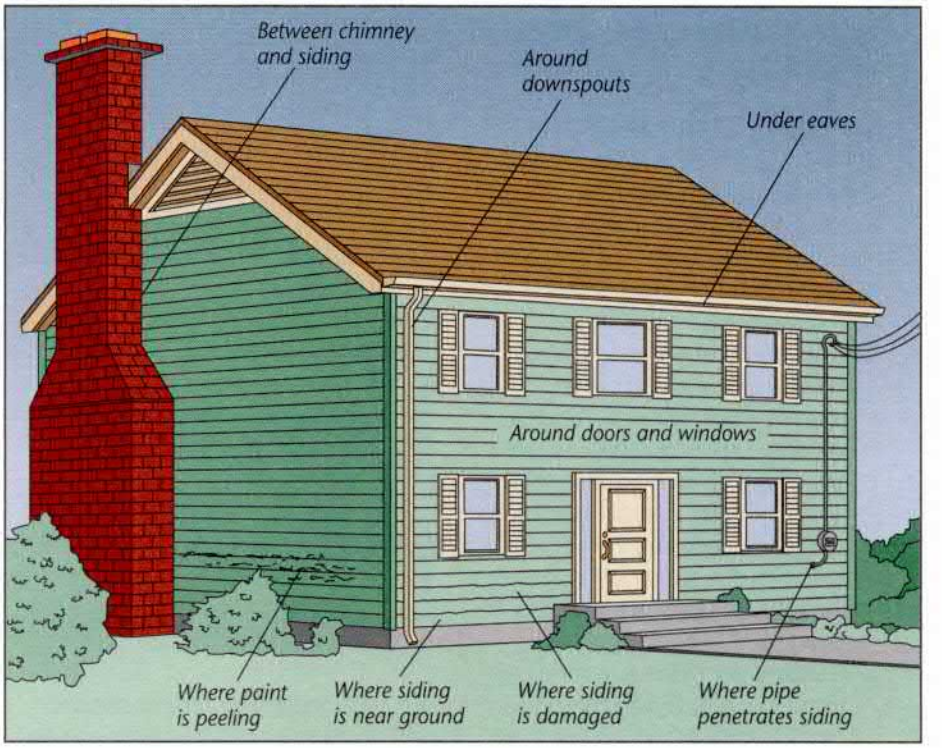
Begin with a visual inspection: the drawing at right indicates vulnerable areas. When you make your actual inspection, let the following list of problems and solutions guide you:

- **Deteriorated caulking.** Make a note of any caulking that has dried out and renew the seals *(page 49)*. Check the seals around windows and doors, around protrusions, and where a deck or masonry fireplace adjoins the house. Also caulk any cracks in board siding.
- **Defective paint.** Often, repainting the defective area is all that's needed. To treat minor paint problems, see page 42. If necessary, repaint all the siding.
- **Cracks.** Long, vertical cracks in masonry walls may indicate settling. Place tape over a crack and leave it in place for several months. If the tape twists or splits, consult a professional to determine if there's a serious structural problem; otherwise, repair the cracks *(pages 46-47)*.
- **Mildew.** Combined heat and humidity may mildew wood and painted surfaces. To retard mildew, see the cleaning tips at right.
- **Efflorescence.** Brick or stone veneer may become covered with a white powder called efflorescence, formed when water-soluble salts are washed to the surface. In an old wall, this may indicate a leak that should be fixed. Cleaning the siding will remove the efflorescence.
- **Dry rot and termite damage.** Dry rot is a fungus that causes wood to crumble; termites destroy wood by chewing out its interior. Both can work away at wood timbers and siding so inconspicuously that they can easily escape your notice.

  To detect damage by termites, probe the edges of wood siding with a knife and look for soft, spongy spots. Pay special attention to any part of the siding that's close to or in contact with the ground, even indirectly.

  Check for visible evidence of termites; look for their translucent, 1/2-inch-long wings or the mud tubes they sometimes build (usually visible from under the house). If you find evidence of dry rot or termites, consult a licensed termite inspector or pest control professional.

Siding problem areas



Cleaning your siding. To keep siding in good shape, hose it down and, if necessary, brush it with a car-wash brush that attaches to a hose.

Hose down vinyl panels and sponge them with a mild liquid detergent.

If brick veneer suffers from efflorescence, scrub the siding, one small area at a time, with a mild solution of muriatic acid (1 part acid to 10 parts water) and rinse the wall well with clear water. Do not use this cleaning method on stone veneer.

You can retard the growth of mildew by washing the siding with a solution of 1/3 cup detergent and 1 quart household bleach in 3 gallons of water. Brush or sponge the walls, then rinse.

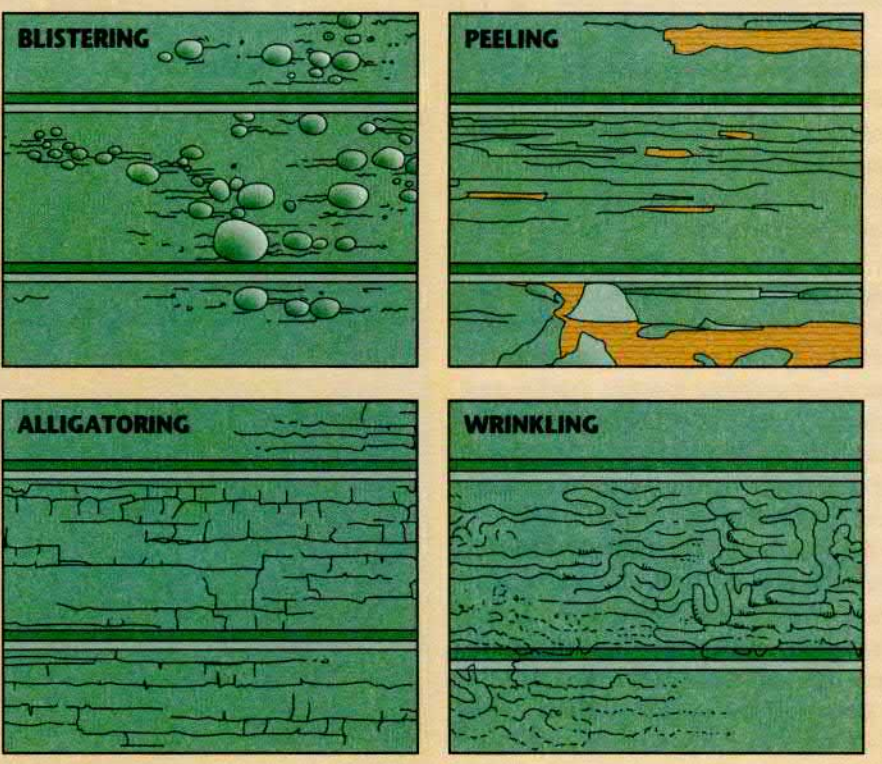
CAUTION: When working with cleaning agents, wear goggles and gloves, and cover your plants with a plastic tarp.

After cleaning the siding, repair any caulking *(page 49)* and paint or stain any areas that are chipped or peeling.

Solving Exterior Paint Problems

Paint damage on exterior wood surfaces can result from any of a number of causes. Before you repaint, try to diagnose the cause of the problem so your repair will be lasting. Then you can prepare the surface, select an appropriate paint or stain, and apply the finish, as explained below.

Common paint problems



DIAGNOSING PAINT PROBLEMS

Typical causes of paint damage include improper surface preparation, careless painting, use of the wrong paint, and structural problems that trap moisture in the wood. Common paint problems and their causes are described below.

- **Blistering.** Blisters appear in paint when water or solvent vapor is trapped under the paint. To relieve the blister and find its cause, cut the blister open. If you find bare wood underneath, it's a water blister created by moisture escaping from damp wood. If you find paint, it's a solvent blister, usually caused by painting in direct sunlight or on wet wood.
- **Peeling.** Paint often peels and curls away from wood when it's applied over dirty, greasy, or wet wood, or over loose paint.
- **Alligatoring.** A checkered pattern of lines and cracks resembling alligator skin results when the top coat is applied before the bottom coat is dry, or when the paints in the bottom and top coats are incompatible.
- **Wrinkling.** Wrinkles in paint are the result of careless painting. If paint is applied too thickly, the top surface dries too rapidly and the paint underneath droops down.
- **Chalking.** High-quality exterior paint is designed to chalk so rain will clean dirt from the surface. But chalking that comes off when you rub up against the surface indicates that the surface was unprimed or finished with paint of poor quality.

PREPARING THE SURFACE

Wood surfaces must be clean, dry, and in good condition before you repaint. Repair any damaged boards, trim, or shingles and fix any structural damage that allows water to penetrate. *(See pages 43-49 for repair instructions.)*

Remove dirt and all loose, peeling, or blistering paint with a stiff wire brush or paint scraper. Where paint damage is severe, remove the paint down to the bare wood. Feather the edges of any remaining sound paint with medium-grade sandpaper, then sand again with fine-grade sandpaper. If the top coat did not adhere to a previous coat, rough up the damaged paint with medium-grade sandpaper.

Wash greasy or very dirty wood with a mild detergent, hose it off, and let the wood dry before painting.

If moisture is causing paint damage, apply a water repellent, prime with an oil-base prime coat, and cover with two coats of high-quality paint after preparing the surface.

APPLYING THE FINISH

Apply a clear waterproofing sealer to the ends of all boards to prevent water from penetrating. Brush a prime coat on bare or new wood. Where heat and humidity cause wood to deteriorate quickly, treat boards with a wood preservative before sealing.

With the exception of redwood, cedar, and southern red cypress (which should be sealed to help retard color changes), wood needs to be painted or stained to protect it from the elements. Use a matching finish; a 2-inch brush for trim and a 4-inch brush for wider surfaces. For larger areas, you may want to use a 9-inch roller; choose a fine nap for smooth surfaces and a thick nap for textured surfaces.

Exterior painting is best done in fair, dry weather with temperatures between 50° and 90°F. Wait until the morning dew has evaporated and stop painting before evening dampness sets in. Don't paint when conditions are windy or dusty, particularly if you're using a solvent-base paint.

WOOD SIDING

Wood siding, whether boards, shingles, or shakes, is so durable that with annual upkeep, it should last the life of the house.

To prevent deterioration of board siding, repair simple surface problems—holes in the wood, split or warped wood, and damaged paint—as soon as they appear *(see below and facing page)*. Severely damaged board siding will need to be replaced *(pages 44-45)*.

When shingles or shakes are damaged, it's usually best to replace them, since repairs to these materials are hard to conceal. Instructions for replacement appear on page 45.

Be sure to determine the cause of any serious damage before replacing siding. If moisture is causing the problem, find the source by checking for deteriorating roofing *(page 29)*, leaking gutters or downspouts, and poor drainage *(pages 36-37)*. Consult a professional if you can't locate the source of the leak. Once you pinpoint the problem, be sure to make the necessary repairs; new siding installed over problem areas will just deteriorate again after a short time.

If after removing damaged siding you see evidence of dry rot or insect infestation *(page 41)*, call in a professional.

Repairing Board Siding

Damage to wood board siding can often be repaired inconspicuously. Repairs usually involve filling holes, fixing split or warped boards, and repainting. Siding that's badly damaged should be replaced *(pages 44-45)*.

Repairing holes. Small holes in board siding can be filled with wood putty, available at lumber and paint stores. The putty comes in a variety of shades for matching lightly stained wood.

To conceal a small hole, fill it with wood putty and allow the putty to dry completely. If the hole is fairly large, apply the putty in layers, letting each one dry completely before applying the next. When the final layer is dry, sand the surface smooth. Then finish the putty to match the surrounding siding (unless you've used putty in a shade that matches the exterior).

Repairing spilt boards. A clean split or crack can be repaired by prying the board apart and coating both edges with waterproof glue, as shown at right. Then either nail or screw the board back into position or, for a less visible repair, drive a row of temporary nails just under the lower edge of the board and bend them up over the edge to hold the board in place. Remove the nails once the glue has set completely.

Repairing warped boards. Warped or buckled boards usually show up where boards have been fitted too tightly during installation. If a board has nowhere to expand when it swells with moisture, it warps or buckles.

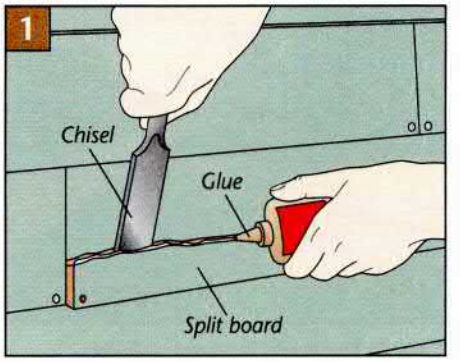
To straighten a warped or buckled board, first try to pull it into line by driving long screws through it and into the wall studs. Use a portable electric drill to drill pilot holes and countersinks for the screws *(page 15)*, then insert the screws and tighten them. Cover the screw holes with wood putty; then sand and finish the area as you would after repairing holes in siding.

If that doesn't work, you'll have to shorten the board to give it more room. Pull out the nails within the warped area or cut them with a mini-hacksaw blade. Continue removing nails to the nearest end of the board. Pull the end of the board outward; then file it with a rasp, sand with sandpaper, or use a block plane to remove wood on the end little by little until the board fits. Renail the board.

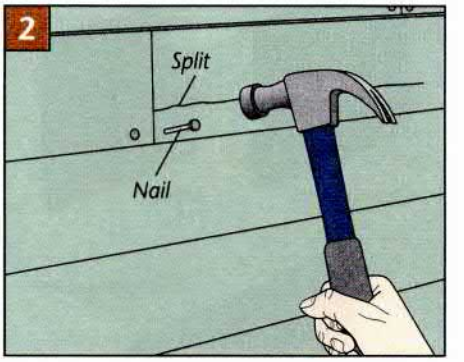
Fixing paint problems. Paint problems can result from a variety of causes: wrong paint, improper surface preparation before painting, careless painting, harsh sunlight over a long period of time, or improper wall ventilation. Except in the last case, the problem can be remedied with a proper paint job *(see facing page)*.

Ventilation depends on your climate and the presence or absence of a vapor barrier. Increasing the amount of ventilation may involve adding vents to the roof, gables, and soffits *(page 39)* or installing a fan *(pages 184-185)*. Check your local building codes for the recommended ventilation for your home.

Repairing a split board



Carefully pry the damaged board apart at the crack and liberally coat the edges of both pieces with waterproof glue.



Push the edges of the two pieces tightly together, predrill holes, and secure both sections to the sheathing with nails.

Replacing Damaged Boards, Shingles, & Shakes

Sometimes, a board is so badly damaged that your only choice is to replace it. A shingle or shake that's damaged should be replaced rather than repaired.

REPLACING BOARDS

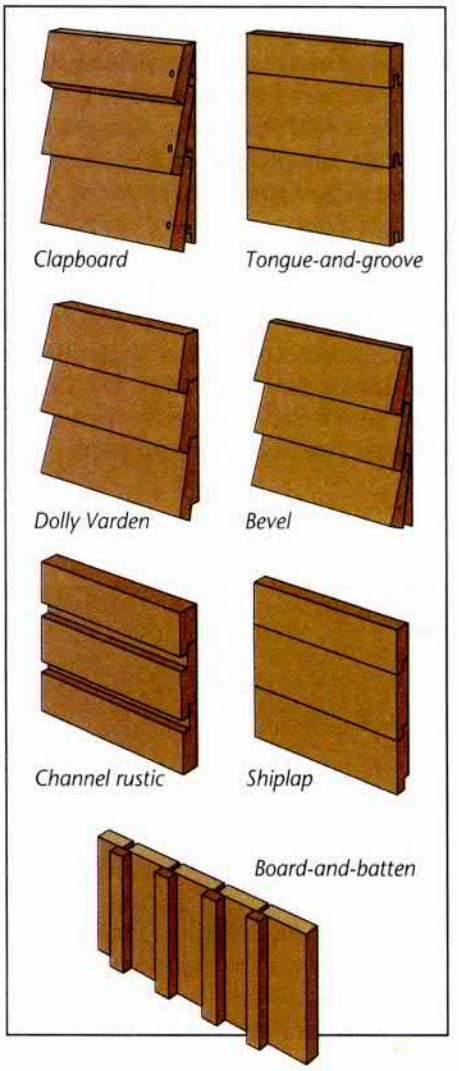
The approach to replacing board siding depends on the milling of the boards (common types are shown below) and how they're nailed. Often, the trickiest part of the job is finding a replacement that matches the original.

No matter what type of siding you're replacing, you'll have to cut the damaged piece and remove the nails in order to pry it out. After repairing any damage to the building paper with roofing cement, you'll need to cut the new piece so it will fit correctly. For best results, cut out and replace a section that spans at least three studs. Pull nails out of the old siding with a nail claw or nail puller, or cut off nail heads with a mini-hacksaw blade.

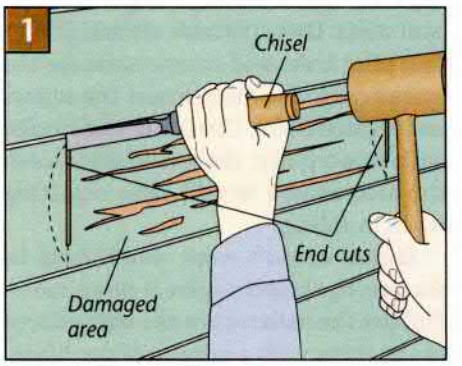
Tongue-and-groove siding. Because the boards are locked together by the tongues and grooves, the damaged piece must be split lengthwise as well as cut at the ends, as shown below, before it can be removed. It's easiest to make the cuts with a circular saw; set the blade depth just shy of the thickness of the siding. Saw almost to each edge, holding the blade guard back and dipping the moving blade down into the wood to start each cut. Hold the saw firmly; it may kick back.

Overlapping styles of siding. Clapboard, bevel, Dolly Varden, shiplap, and other overlapping styles *(see below at left)* are face-nailed to studs or sheathing. Though the boards overlap, you can replace a dam-

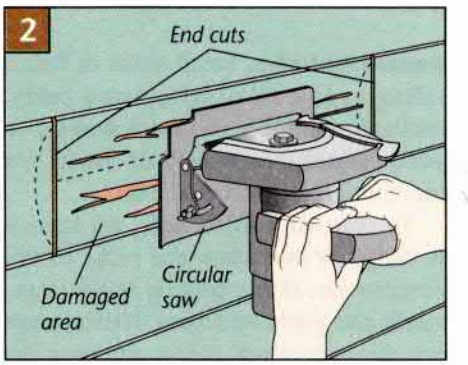
Common board sidings



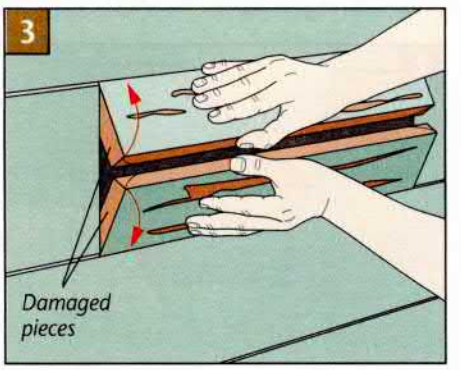
Replacing tongue-and-groove siding



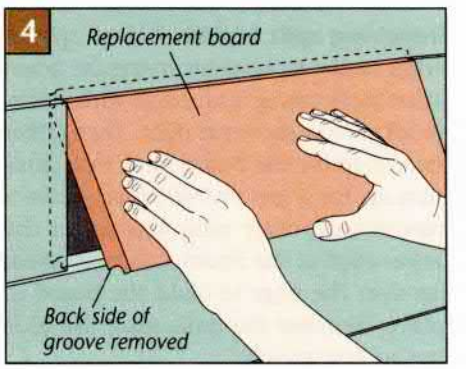
Pull out all exposed nails in the area to be removed. Mark the end cut lines, then cut with a circular saw almost to the bottom and top of each mark. Finish cuts with a chisel.



Rip along the center of the damaged section with the circular saw, cutting almost to the end cuts. Again complete the cuts at both ends with a hammer and a chisel.



Cave in the board; then pull out the loosened pieces. If you find any cuts or tears in the building paper, repair them with roofing cement.



Remove the back side of the groove on the replacement board; slide it in place and face-nail the board. Countersink the nail heads, caulk the nail holes and ends, and finish.

aged piece without removing other boards (you may need to pry up the board above the one you're replacing to free the last pieces of damaged board). To replace all types of overlapping siding, follow the directions for replacing clapboard siding illustrated below.

To provide a solid nailing base for the replacement board, center the end cuts over studs, if possible. You can use a backsaw to cut clapboard, bevel, and Dolly Varden siding; make the cuts in shiplap and channel rustic siding with a circular saw, as described for tongue-and-groove siding on the facing page. If nails are in the way of your saw cuts, pull them out.

Board-and-batten siding. To remove board-and-batten siding, pry up the battens on each side of the damaged board far enough to raise the nail heads, then pull out the nails. Repeat this process until you're able to remove the damaged board.

Patch any cuts or tears in the building paper with roofing cement. Replace the damaged board and batten with identically sized new ones. Seal all joints with caulking compound; then stain or paint.

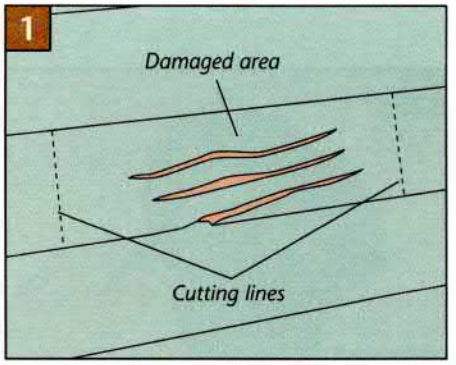
REPLACING SHINGLES & SHAKES

When a shingle or shake splits, curls, warps, or breaks, you'll have to remove it and replace it. The replacement technique depends on whether the shingles or shakes are applied in single or double courses (rows).

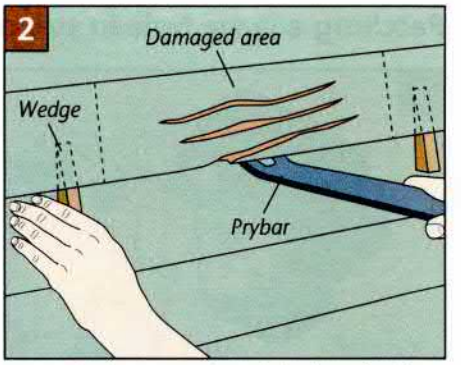
In a single-course application, each course overlaps the one below by at least half a shingle or shake length. The nails are concealed under the shingles or shakes of the course above. Replacement procedures are the same as for a shingle or shake roof *(page 32)*.

Double-coursing calls for two layers of shingles or shakes. Here, the nail heads are exposed. To replace a damaged shingle or shake, simply pull out the nails, remove the damaged piece, slide in a replacement, and nail.

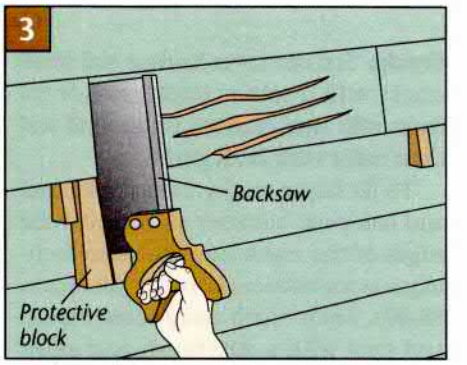
Replacing clapboard siding



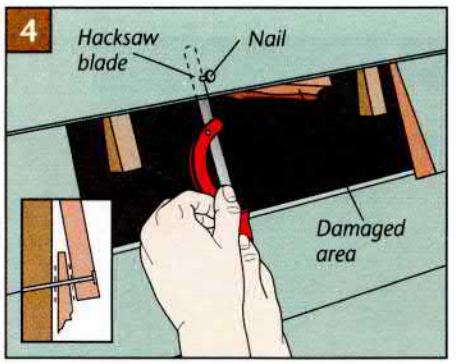
Mark cutting lines on each side of the damaged area, centering the lines over wall studs. (If the damage is near a joint in the siding, you'll need to make only one cut.)



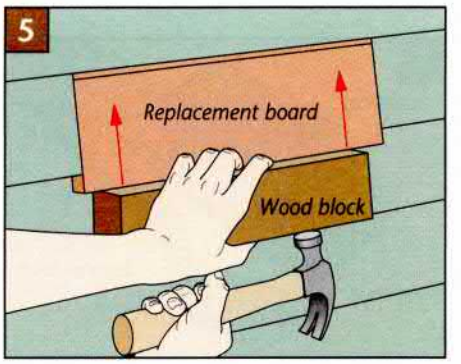
Pry up the bottom edge of the board with a prybar or stout chisel. Drive small wedges underneath the board at either end outside the cutting lines to keep it raised.



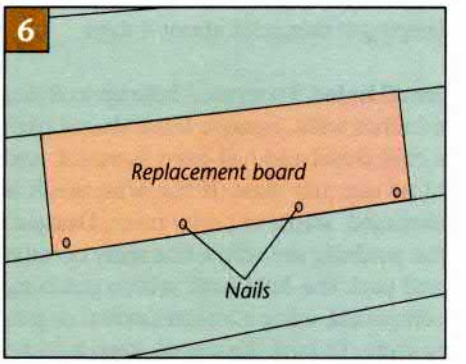
Cut through the board along both cutting lines using a backsaw; finish the cuts with a keyhole saw or a chisel. Break the damaged board out—in pieces, if necessary.



Cut any nails passing through the board above with a mini-hacksaw blade to free the top of the damaged board. Repair any tears in the building paper with roofing cement.



Trim the replacement board to the right length and drive it into the exact position, hammering against a wood block placed along its lower edge.



Nail down the replacement board to match the existing siding and caulk the nail holes and board ends. Stain or paint the new board to match siding.

STUCCO SIDING

Stucco walls typically consist of three layers of stucco applied over self-furring spacers and wire mesh. The final coat is either pigmented or painted and can be textured in a variety of ways.

Cracks and holes in stucco can result from several causes, including poorly applied or poor-quality stucco and settling. To protect the house from moisture damage, repair damaged stucco right away.

The keys to a successful repair job are slow curing of the patched stucco and careful matching of the color and texture of the patch to the existing wall. To match color, you can either add pigment to the final coat of stucco or paint that part of the wall later on. Texturing is done with floats, trowels, or brushes.

Following are directions for repairing cracks, small holes, and large holes.

Cracks. You can cover hairline and small cracks with a coat of latex paint or fill them with latex caulking compound and then paint with latex paint.

To fix larger cracks, use a cold chisel and ball-peen hammer to undercut the edges of the crack (use the same technique as for interior plastered walls, pages 88-89). Then brush away loose stucco and dust with a stiff brush and paint around the edges of the patch with a concrete bonding agent.

With a mason's trowel or putty knife, fill the crack with stucco patching compound, packing it tightly; texture to match the surrounding stucco. Cure the stucco by keeping it damp for about 4 days.

Small holes. To repair a hole up to about 6 inches wide, remove loose stucco with a cold chisel and ball-peen hammer, and blow out any dust. If the wire mesh is damaged, staple in a new piece. Dampen the patching site with a fine spray of water and pack the hole with stucco patching compound, using a mason's trowel or putty knife. To cure the stucco, keep it damp for about 4 days.

Large holes. Holes larger than about 6 inches wide should be repaired using the same methods as for applying new stucco. You'll need three coats of stucco—a "scratch" coat, a "brown" coat, and a final coat that is colored. You can buy it this way, and texture it to match the original.

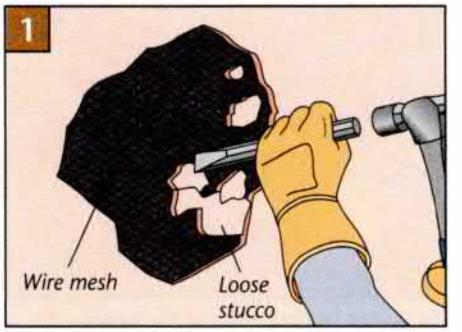
For the first and second coats buy a bag of stucco mix. Add 1/10 part lime for easier working. Mix with enough water to make a fairly stiff paste. For the final coat purchase a stucco color coat mix in the desired color.

To apply the stucco *(see illustrations below)*, first prepare the surface by removing all the loose stucco, adding new wire mesh if necessary and applying a concrete bonding agent to the edges. Be sure to press the first coat well into the mesh for a good bond. When this coat is firm, scratch it all over with a nail to provide grip for the second coat. Tape a plastic sheet over it to keep it damp and let it cure for 2 days.

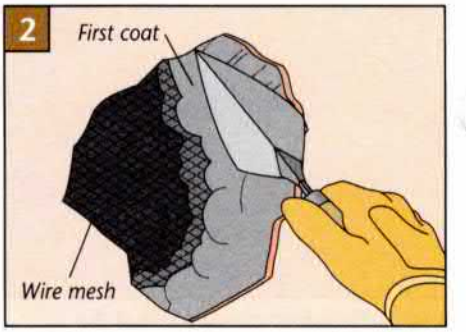
Dampen the area with a fine spray of water before applying the second coat and keep the second coat damp for 2 days.

The final coat, the one you texture, should be flush with the surrounding wall. While it's wet, texture it to match (you'll have to experiment). For a smooth texture, draw a metal float across the surface. For other textures, daub a sponge or brush on the surface, or splatter with more stucco and smooth down high spots. To cure stucco, cover with a plastic sheet and keep it damp for about 4 days. Wait a month after curing if you need to paint it.

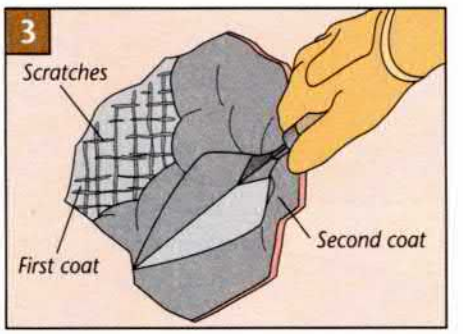
Patching a large hole in stucco



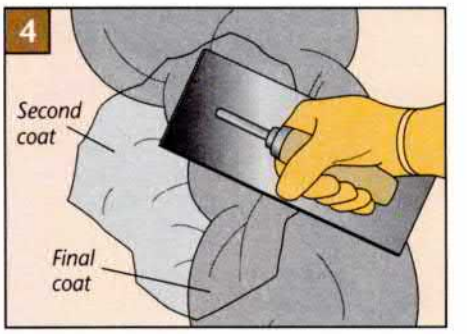
Remove loose stucco from the hole with a cold chisel and ball-peen hammer; blow out the dust. Staple new wire mesh over any damaged mesh. Spray with water.



Apply the first coat of stucco to within 1/4 inch of the surface, using a mason's trowel (stucco should ooze behind mesh). When firm, scratch with a nail. Cure for 2 days.



Apply the second coat over the dampened first coat to within 1/8 inch of the surface, using a mason's trowel or putty knife. Smooth the stucco and let it cure for 2 days.



Apply the finish color coat over the dampened second coat with a metal float. Smooth it flush with the existing surface. Texture as desired; cure for 4 days with plastic over top.

BRICK VENEER

Brick-veneer siding is usually applied to a wood frame wall over building paper; the mortared joints may be "tooled," or finished, in a number of ways, as shown at right. Properly tooled joints are essential to ensure strong, watertight walls.

Problems with brick veneer. Most problems develop at the mortar joints. Sometimes the mortar shrinks, causing the joints to open; old-fashioned lime-based mortar often crumbles. Freeze-thaw cycles in cold-winter climates, excess moisture, and settling also result in mortar problems.

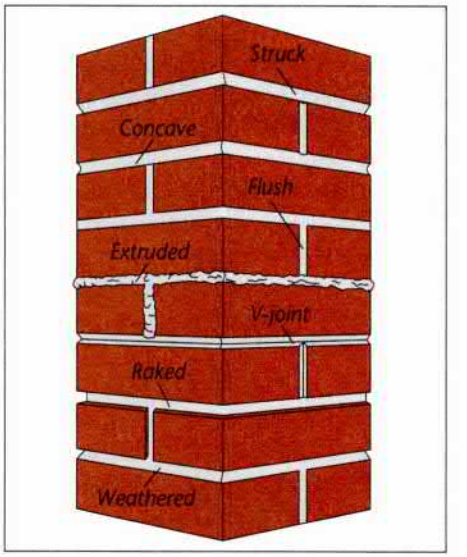
Repointing mortar. To repair cracked or crumbling mortar, you'll have to remove the old mortar and "repoint" the joints (fill them with new mortar), as shown below.

Though you can make your own mortar, it's easier to use dry ready-mixed mortar (use weather-resistant type N), available at building supply stores. Prepare the mortar according to package directions. When you're filling the joints, you may want to use a special tool called a hawk *(illustrated below)* to hold the mortar conveniently close to the job.

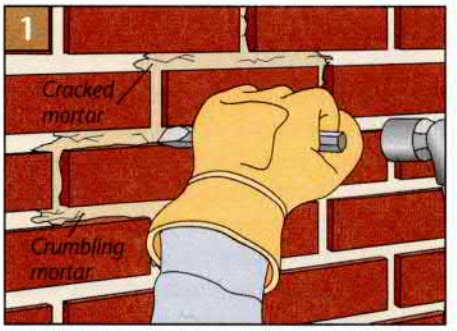
Using a jointer, steel rod, or trowel, tool the new joints to match the existing ones. Mortar joints should be tooled when they are "thumbprint hard" (neither so soft that they smear the wall nor so hard that a metal tool leaves black marks). Keep tooled joints damp for 4 days to cure.

CAUTION: When chipping out old mortar with a ball-peen hammer and cold chisel, protect your eyes with goggles.

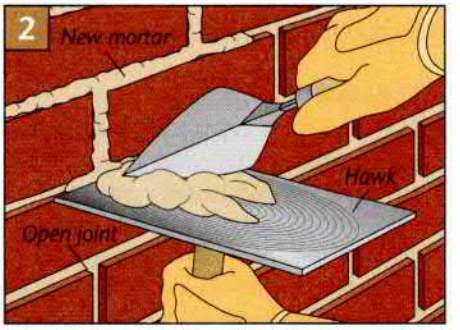
Types of mortar joints



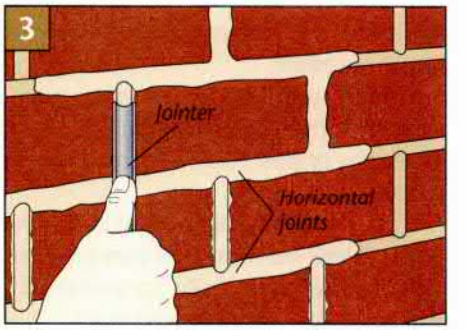
Repointing damaged mortar joints



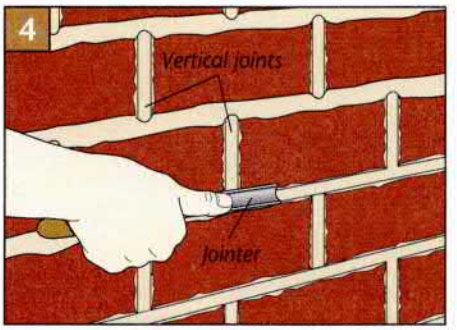
Chip out cracked and crumbling mortar to a depth of at least ½ inch, using a cold chisel and ball-peen hammer. Clean the joints with a wire brush and dampen them.



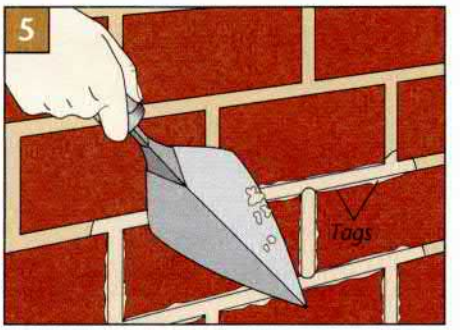
Pack mortar into dampened (not wet) open joints, using a small trowel and a hawk. Tamp the mortar with a trowel or piece of wood.



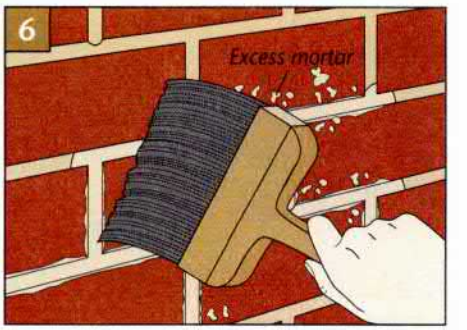
Finish the vertical (head) joints when the mortar is thumbprint hard by pressing and drawing a jointer (or other appropriate tool) along each joint.



Finish the horizontal joints in the same manner as the vertical ones, pressing and drawing the tool along each joint.



Cut off the tags (excess mortar) by sliding the trowel along the wall. Finish the horizontal and vertical joints again *(see Steps 3 and 4)*.



Brush the wall with a stiff brush or broom once the mortar is well set. Keep the joints damp for 4 days to allow the mortar to cure.

ALUMINUM & VINYL SIDING

Both aluminum and vinyl siding panels have interlocking flanges along both edges. The panels are nailed to the sheathing through slots along one flange; the other flange interlocks with the adjacent panel. Panels may be installed vertically or horizontally.

You can successfully repair minor dents, scratches, and corrosion in aluminum siding. More extensive damage usually can't be repaired; instead, the siding must be replaced, as shown below.

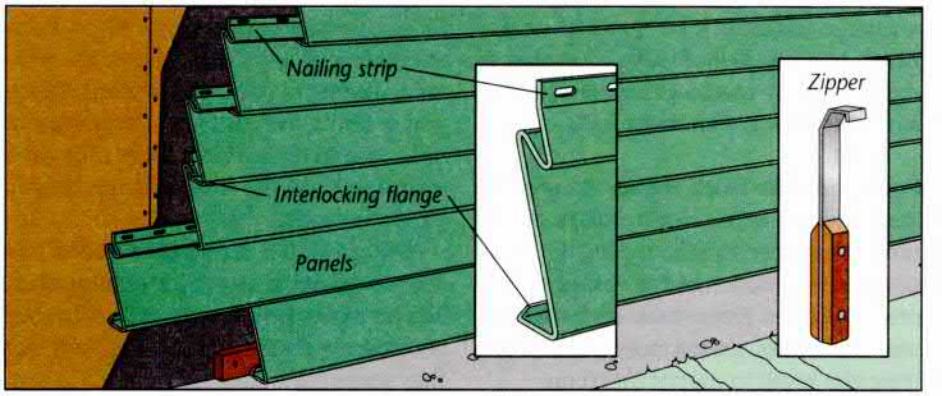
REPAIRING ALUMINUM SIDING

To remove a dent in aluminum siding, drill a hole in the center of the dent and screw in a self-tapping screw with two washers under the screw head (the screw cuts its own thread as it is driven in). Gently pull on the screw head with a pair of pliers. Remove the screw and fill the hole with plastic aluminum filler (follow directions on the tube). When dry, sand the filler smooth and touch up with matching paint.

Conceal scratches in aluminum siding by applying metal primer over the scratch. When the primer is dry, coat with acrylic house paint.

Clean corroded areas with fine steel wool. Prime the area with rust-resistant metal primer, specifically for aluminum, and cover with acrylic house paint.

Typical aluminum or vinyl panels



REPLACING ALUMINUM SIDING

If a section of your aluminum siding is damaged beyond a simple surface repair, you can replace it by cutting out the damaged part of the panel, leaving the nailed portion in place *(see below)*. Use tin snips to cut the new section of siding (it should overlap the existing siding by 3 inches on each side); then install it.

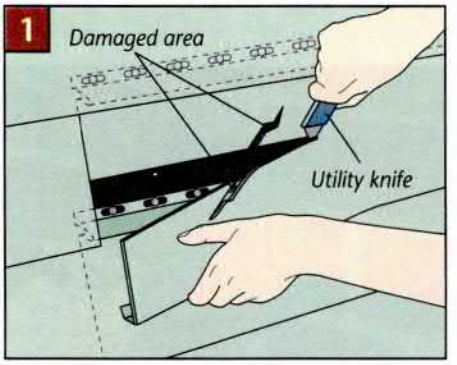
REPLACING VINYL SIDING

If vinyl siding is cracked or punctured, you must remove the entire damaged section before you can install a replacement piece. To do this, you'll need a special tool called a "zipper" to separate the interlocked panels. It's best to do the work during warm weather, when the vinyl is pliable.

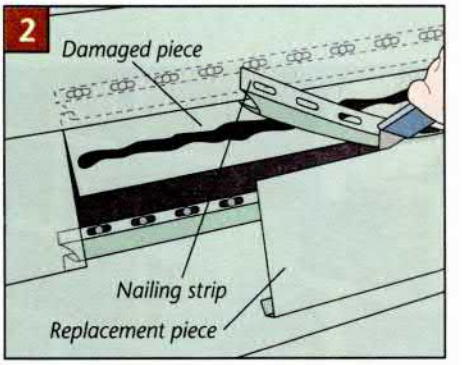
Using the zipper, unlock the panel adjacent to or above the damaged one and lift it up to expose the nails securing the damaged panel. Pry out the nails. Mark cutting lines on each side of the damaged area, using a carpenter's square and pencil. With tin snips or a backsaw, cut the panel along the lines and remove the damaged section.

Cut a replacement piece 2 inches longer than the section you just removed to allow for a 1-inch overlap on each end. (Cut only 1 inch longer if the damaged section ends at a corner or joint.) Snap the top edge of the new section in place and nail it with aluminum box nails long enough to penetrate 1 inch into the studs. Using the zipper, snap in the other edge.

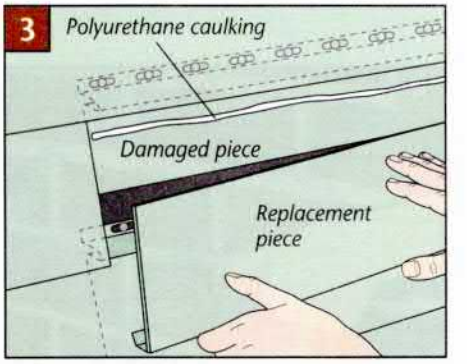
Replacing a damaged section of aluminum siding



Cut through the center of the panel to just beyond both sides of the damaged area. Make vertical cuts on both ends; remove the lower half of the damaged section.



Cut the nailing strip off the replacement with a utility knife (the new piece should be 6 inches longer than the damaged section, 3 inches if one end is at a joint or corner).



Generously apply polyurethane caulk or lap seal to the damaged panel. Press the new piece in place so each end overlaps existing siding by 3 inches. Hold or prop until dry.

EXTERIOR CAULKING

Exterior caulking compound sheds rain and prevents water from penetrating the inner walls. It will eventually dry out and require renewal, so always check for cracked, loose, or missing caulking as part of your spring and autumn maintenance inspections.

The different types of caulking compound, the areas around your house that require caulking, and the application techniques are discussed below.

Types of caulking. The four basic types of exterior caulking are elastomers, acrylic latex, nonacrylic latex, and oil base. The chart on page 25 lists the characteristics of each. When making your choice, weigh price against each compound's expected lifetime and consider the kinds of materials to which the caulking must adhere. Also consider whether or not you will be caulking a moving joint. If so, the job calls for an elastomeric sealant.

Caulking comes in four forms: as disposable cartridges for use with a double-strap caulking gun, in a can for application with a full-barrel caulking gun or a putty knife, in a small squeeze tube, and as rope caulk. The double-strap caulking gun fitted with a cartridge is the most popular dispenser, since it's the easiest to use for applying an even bead of compound. For very wide cracks or joints, you can use foam ropes to fill the gap and apply caulking to finish.

CAUTION: Before you buy any caulking, be sure to read the label: Some types won't work in cracks or joints less than 1/4 inch wide; others work well only in narrow cracks. Take note of any listed precautions and follow the directions when you're using the product.

Where to caulk. Generally, you'll need to caulk in areas where different surfaces meet. Here are some of the places requiring caulking:

- On the roof where one flashing meets another flashing; between flashing and a roof or dormer surface; and where a chimney, flue, plumbing or electrical pipe, attic fan, or skylight protrudes through the roof surface.
- On the siding where the siding and trim meet at corners; around window and door frames; between badly fitting pieces of siding; where pipes and other protrusions pass through the siding; and where the siding meets the foundation, patio, or deck. Do not caulk every joint in the siding; overlaps and J channels should be left uncaulked so they can expand and contract.

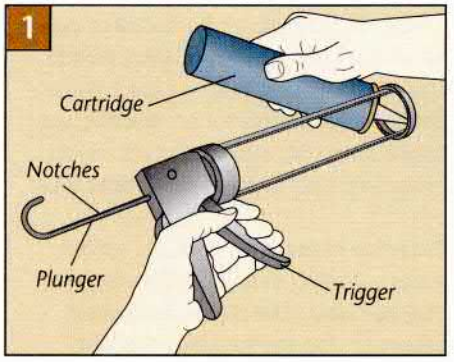
It's also a good idea to check interior window and door frames, especially between sliding door or window tracks and the sill or jamb.

Applying caulking. Before you can apply new caulking, you'll have to remove the old or damaged sections. Dig out or chip off the old caulking with a putty knife, old screwdriver, or scraper. Then brush with a wire brush to remove debris and wipe the surface with a cloth soaked in the appropriate solvent for the caulking you're removing. Check the new caulking's label to see if you need to prime the surface.

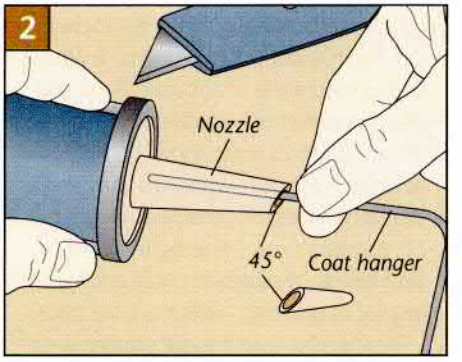
Plan to caulk on a warm, dry day when the temperature is between 50° and 70°F. In hotter weather, refrigerate the caulking for an hour or two before use so the compound won't run.

Directions for using a double-strap caulking gun appear below. It may take a bit of practice to get the bead of caulking to flow evenly. Start by holding the gun at a 45° angle to the surface; then, moving the gun across the surface, squeeze the trigger to keep the caulking flowing smoothly. Make sure the compound fills the crack completely and overlaps adjoining surfaces evenly. If you're using rope caulk, simply unroll the amount you need and use your fingers to stuff it into the crack.

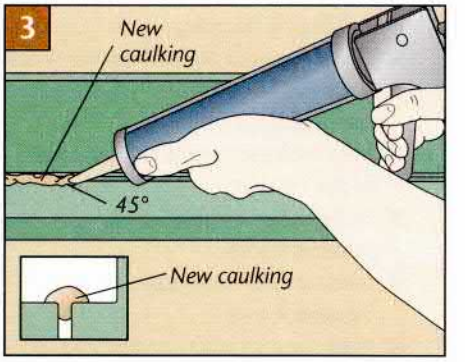
Using a double-strap caulking gun



To load the gun, pull the plunger out (notches should face up). Insert the cartridge, top end first; push the plunger in and rotate it so that the notches face down, then pull the trigger.



Cut off the end of the nozzle at a 45° angle with a utility knife (for a narrow bead, cut close to the tip; cut farther away for a wide bead). Break seal with a nail or coat hanger.



Holding the gun at a 45° angle to the joint, slowly move the gun along the joint as you steadily squeeze the trigger. Make sure the bead overlaps both sides of the crack evenly *(see inset)*.

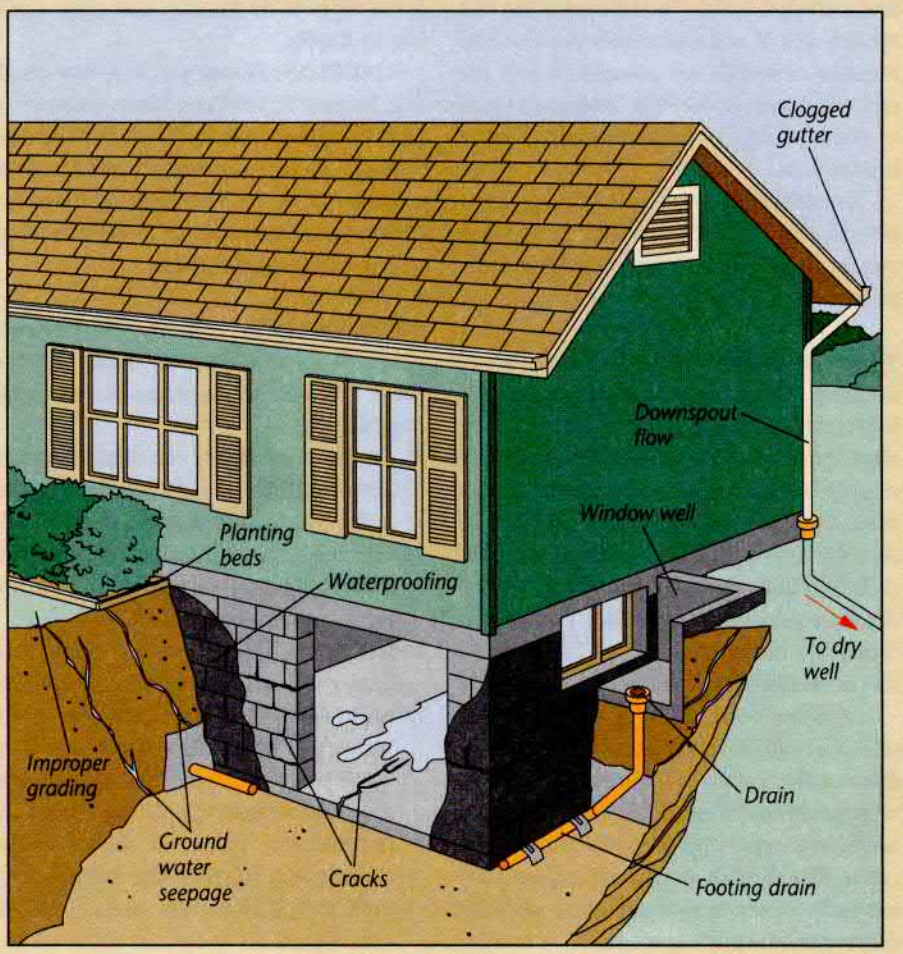
Controlling Moisture in a Basement

The most common basement problem a homeowner faces is water. The problem can range in seriousness from damp walls and floors to water gushing out of a crack. The source may be simply humid air condensing on cool surfaces or ground water finding its way through your basement's walls or floor. Before you can correct the problem, you'll need to determine the source of the water.

Where's the water coming from? If you can see water flowing out of a crack in a wall or floor, you know that the source is ground water. In the absence of such obvious evidence, you'll have to make a test to determine whether the dampness in your basement is caused by condensation or water from the ground.

Cut two 12-inch squares of plastic sheeting or aluminum foil. Tape one to the inside of an outside wall and one to the basement floor (make sure the surfaces are thoroughly dry). After 2 or 3 days, remove the plastic or foil and examine the surface that was next to the wall or floor. If it's dry, the culprit is condensation; if it's wet, it's a sign that ground water is seeping through the wall or floor.

Common causes of a wet basement



REDUCING CONDENSATION

When the basement air is humid, the moisture in the air may condense on cool surfaces, such as the concrete floor.

The following suggestions will help to lower the air's humidity:

- Cover exposed dirt with plastic sheets.
- Raise the temperature in the basement.
- Vent moist air from a clothes dryer to the outside.
- Install a dehumidifier in the basement area.
- Insulate cold water pipes and basement walls.
- Improve ventilation by opening basement windows or installing an exhaust fan (page 185) in the basement.

CONTROLLING GROUND WATER

When water collects next to a foundation wall or when the water table (the water level under your property) is higher than your basement floor, hydrostatic pressure can force water through joints, cracks, and porous areas in concrete walls and floors and through cracked or crumbling mortar joints in masonry walls. Poor construction practices—clogged or nonexistent footing drains, poorly applied or nonexistent moisture-proofing on the foundation, through-the-wall cracks, and improper grading —often are the cause.

Correcting any of these problems is a major job that requires digging out the foundation to the bottom of the footings. Though this may well be the most permanent repair, first try the remedies that follow. If they don't work, then you'll have to contact a foundation engineer or contractor for a more lasting solution.

CAUTION: If you see horizontal cracks in a wall that's bowing inward, long, vertical cracks wider than ¼ inch, or a crack that's getting wider (measure it periodically), you have a structural problem and you should contact a private building inspector at once.

Exterior remedies. Roof and surface water collecting next to the foundation may be causing the dampness in your basement. Use the following checklist and correct any problems you find.

- Gutters and downspouts should be clear and should direct water

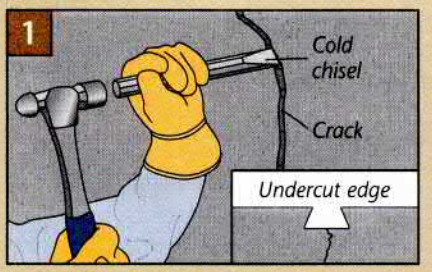
away from the foundation. To clean gutters and improve drainage at downspouts, see pages 36-37.

- Proper grading around the house. The ground should drop 1 inch per foot for the first 10 feet away from the foundation walls—essential to ensure good surface drainage.
- Planting beds next to the foundation should not allow water to collect or pool there.
- Window wells around basement windows should be free of debris, have good drainage, and be properly sealed at the wall.

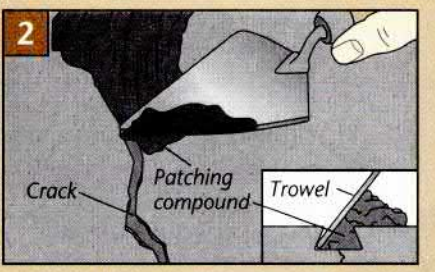
Interior remedies. The following simple interior repairs may alleviate or cure your water problems:

- Apply a coating to the wall. Most coatings are painted on, however some are plastered on with a trowel. Except for epoxy coatings, all are cement-based products with various additives. Epoxy does the best job. Look for coatings at home improvement or masonry supply centers.
- Patch cracks in walls and floors with Portland or hydraulic cement. Hydraulic cement expands and hardens quickly, even under wet conditions. Make sure that any cracks wider than 1/8 inch are undercut—chiseled out so the inside of the crack is wider than the outside (see the illustration for upper Step 1 below). This will prevent water pressure from popping out the patch.
- Chisel out a groove along the wall if water is entering through a floor/wall joint. Fill the groove with hydraulic or epoxy cement and cove (form in a concave shape) as shown in the lower Step 3 illustration below.
- Chisel out cracked mortar joints in masonry walls and fill them with hydraulic or epoxy cement.Water that comes through cracks in a concrete floor or through the joint between the basement floor and wall is caused by hydrostatic pressure. In addition to the procedures described above, remedies for the problem include installing drains under the floor, adding a sump pump, or water proofing the exterior foundation wall by installing bentonite panels—all jobs that are best left to professionals.

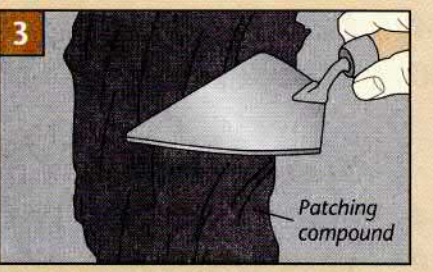
Patching a crack



Chisel out any crack wider than ⅛ inch, undercutting it (see inset) *and beveling the edges. Clean out the crack.*

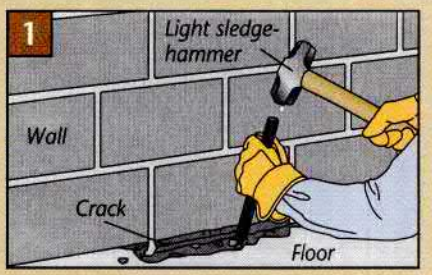


Apply patching compound with the tip of a trowel. Force it well into the crack so the bottom is completely filled.

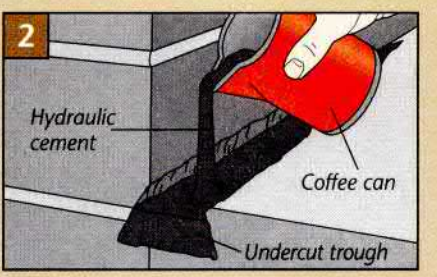


Smooth the patching compound with a wet trowel after it has set so it's flush with the rest of the wall.

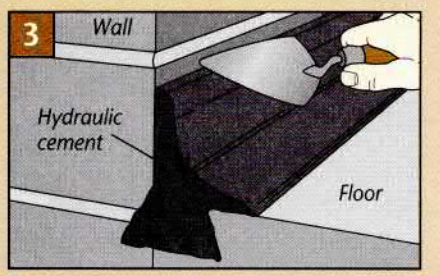
Patching a floor/foundation joint



Chip out the joint with a hammer and cold chisel (wear goggles) to make a groove 1 to 2 inches deep; undercut the edges.



Pour a soupy mixture of hydraulic (or epoxy) cement from a bent coffee can to within 1/2 inch of the top of the groove.



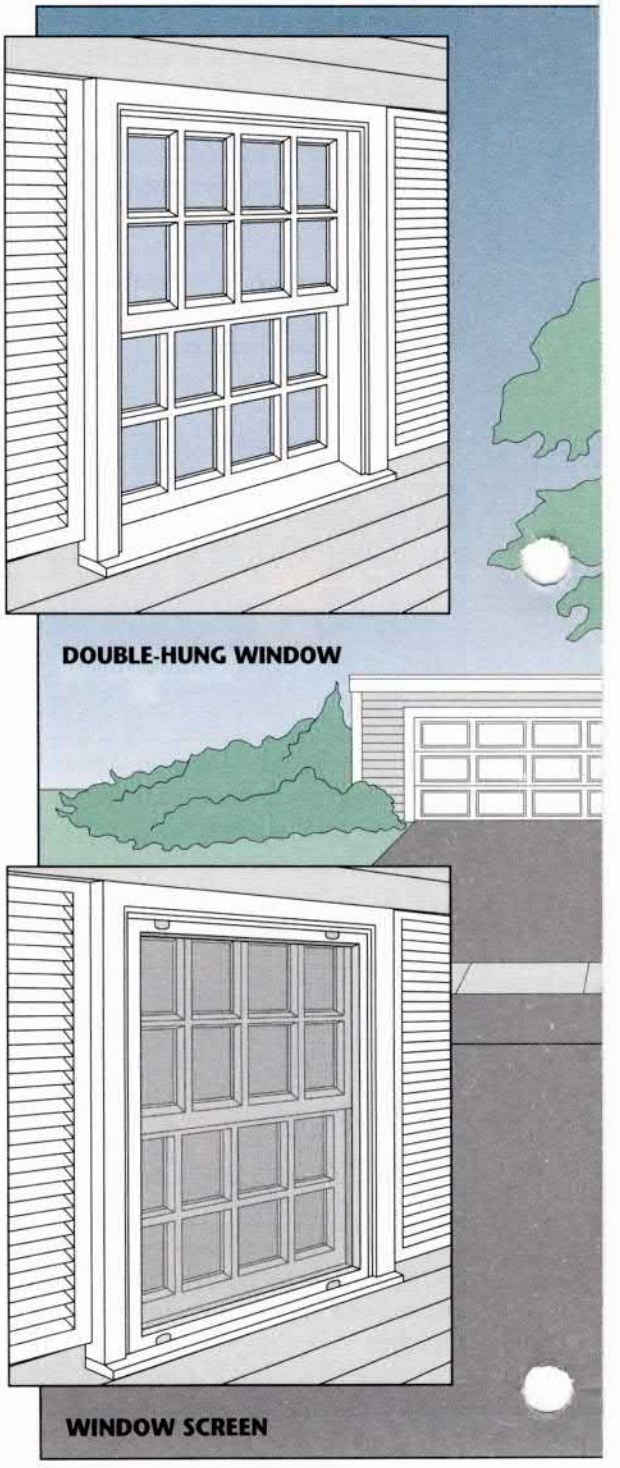
Fill the rest of the groove with a stiffer mixture of the cement, coving it several inches up the wall and along the floor.

Windows & Doors

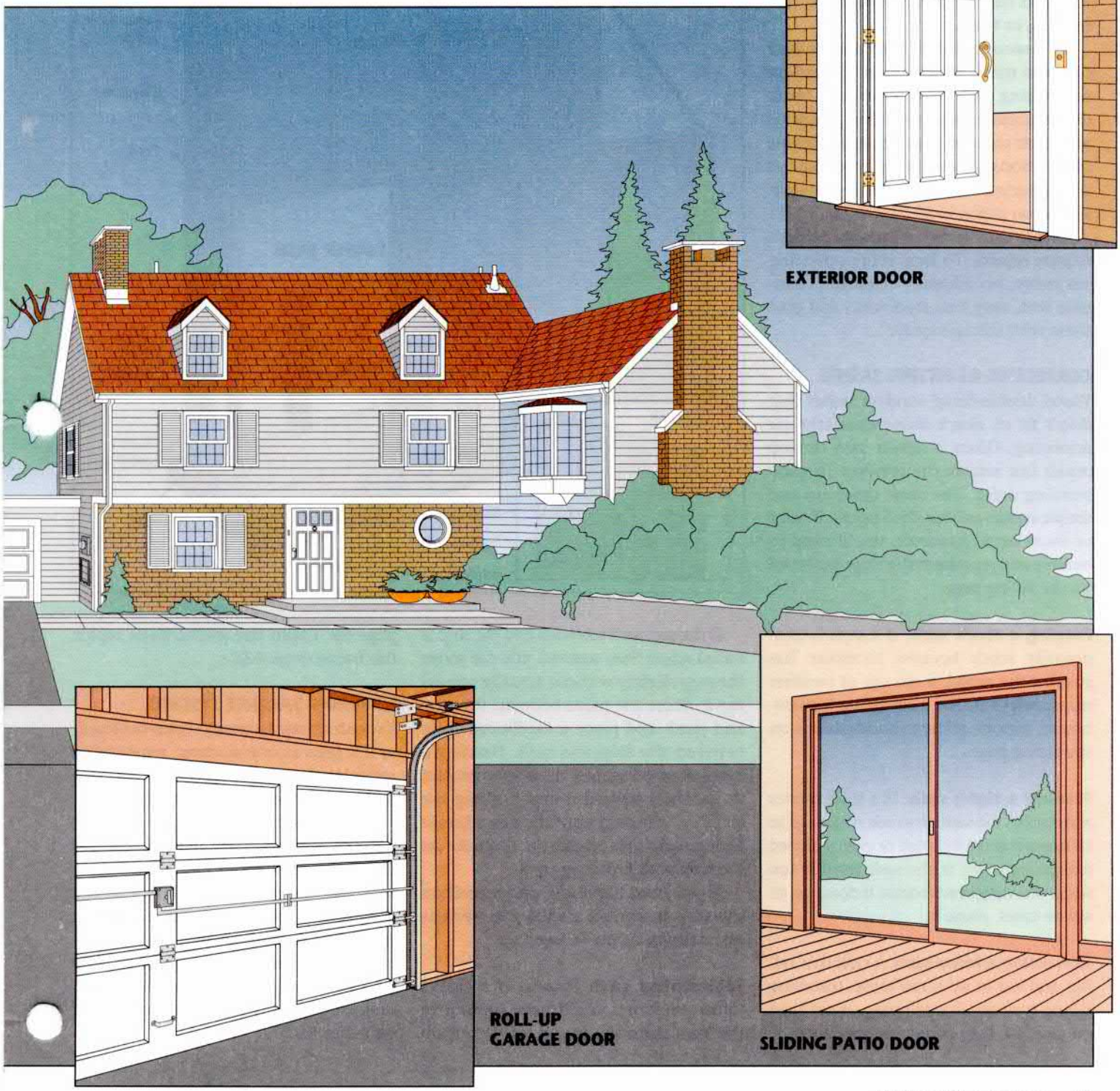
54 *Double-hung Windows*
58 *Casement Windows*
59 *Sliding Windows*
60 *Window Glass*
61 *Window Sills*
62 *Window Screens & Storm Windows*
65 *Hinged Doors*
71 *Door Thresholds & Sills*
72 *Sliding Doors*
73 *Storm & Screen Doors*
74 *Door Locksets*
80 *Garage Doors*

Special Features

64 *Weatherstripping Windows*
78 *Weatherstripping Doors*



Windows and doors open up your house to allow movement of light, air, and people; at the same time, they shield you from the elements—rain, snow, and wind. Shown below are some of the common types of windows and doors discussed in this chapter. Such jobs as repairing a sagging door, a binding window, and a torn window screen are also covered in full detail.



EXTERIOR DOOR

ROLL-UP GARAGE DOOR

SLIDING PATIO DOOR

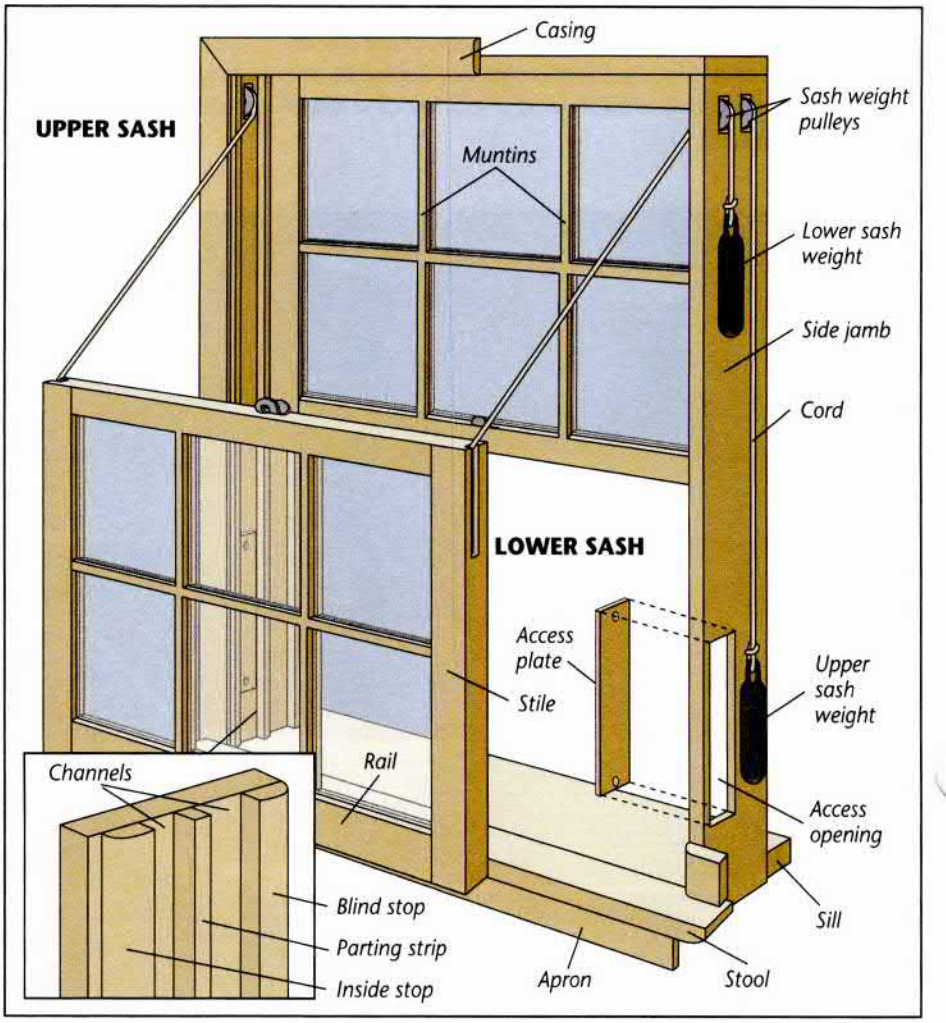
DOUBLE-HUNG WINDOWS

A double-hung window consists of two sashes: an upper, outside sash that moves down and a lower, inside one that moves up. A pulley and weight system or balances located in the jambs counterbalance the weight, making the sashes stay wherever you slide them. Double-hung windows may be made from wood, aluminum, or vinyl.

As a wood window sash ages, it may begin to misfit its frame, or the system controlling sash movement may break down. Some common window problems and their solutions are discussed below. Instructions for removing wood sashes and replacing a window's balance system appear on pages 56-57.

Metal and vinyl windows seldom require repairs. To keep them operating smoothly, occasionally clean the channels with very fine steel wool and coat them with silicone spray.

A double-hung window



CORRECTING ILL-FITTING SASHES

Wood double-hung window sashes that don't fit or don't move correctly are annoying. Often, a simple sash or stop repair can restore the window to good working order. The most common and simple repairs are described below. If none of these work, however, you'll need to remove and reposition the stops as shown on the facing page.

Freeing a stuck sash. If a sash is temporarily stuck because moisture has swelled the wood, a change of weather may correct it. For a sash that's paint-bound, use one of the methods shown on the facing page.

Freeing a tight sash. If a sash moves reluctantly, the sash channels may need to be cleaned and lubricated or even widened *(see facing page)*. If the sash itself is too wide, you may need to sand it down or, in severe cases, plane it.

Correcting a loose sash. A sash that rattles and lets in air is too loose. Installing spring-type weatherstripping, as outlined on page 64, may correct the problem.

If the gap isn't too wide and the stop is nailed rather than screwed, you can move the stop slightly without actually removing it. Score the paint between the stop and jamb and place a cardboard shim between the stop and sash. Holding a block of wood against the stop to protect it, hammer toward the sash along the length of the stop until the paint breaks and the stop rests against the shim. Secure the stop with finishing nails.

If you need to remove and reposition the stop to correct a wide gap, see the instructions on the facing page.

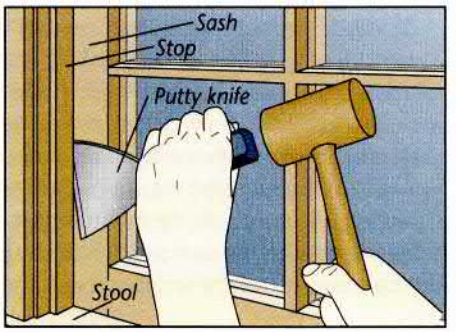
Tightening sash joints. If a sash's joints are loose, you'll have to remove the sash from the frame, as shown on page 56. Clean the joints; then repair the frame *(page 62)*.

REPAIRING BALANCE SYSTEMS

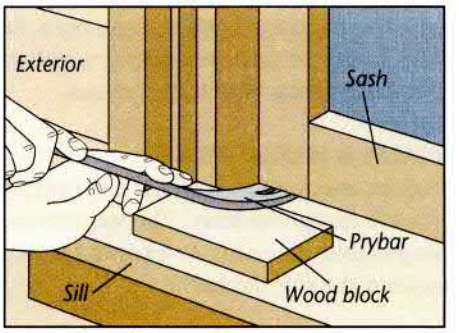
If a sash refuses to remain open or closed, or if it jams in one position, repairing or replacing the balance system are the only routes to correcting this problem.

Windows can have many different balance systems. They may have a traditional weight and pulley balance system, like the one that is shown in the illustration above, or a more modern spiral-lift, tension-spring, or cord balance system, as shown on page 57. The simple instructions for repairing and replacing these balance systems appear on pages 56-57.

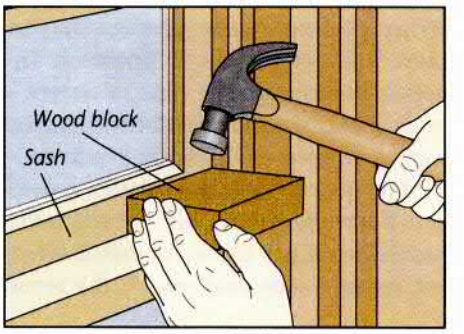
Three ways to free a paint-bound sash



Work a wide putty knife between the sash and frame after scoring the paint along the edges with a utility knife. Tap with a mallet to break the paint seal.

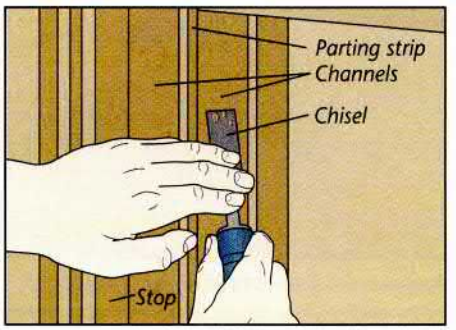


From outside, wedge a prybar between the sill and sash; work alternately at each end so the sash moves up evenly. Protect the sill with a wood block.

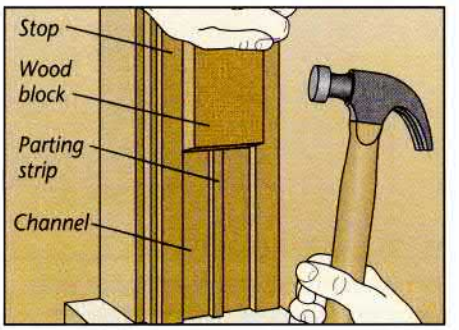


If a window is stuck open and too wide to be pried, place a wood block on the sash at one side; tap with a hammer. Continue, alternating sides, until the sash is freed.

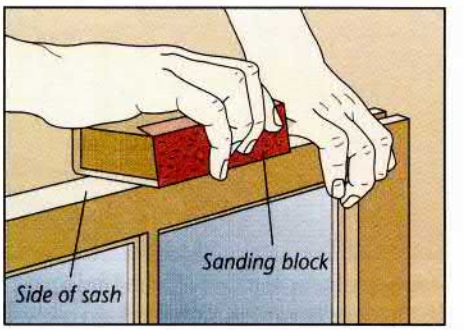
Three ways to loosen a tight sash



Chisel any dirt or large globs of paint from the channels, then sand them smooth. Coat all the surfaces with paraffin so the sash can move easily.

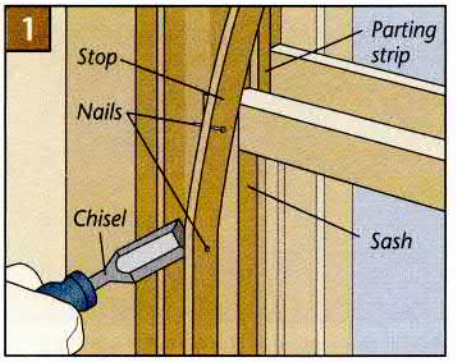


To widen the channel where stops are nailed, place a wood block wider than the channel at the point that binds. Tap the block against the stop until the sash moves.

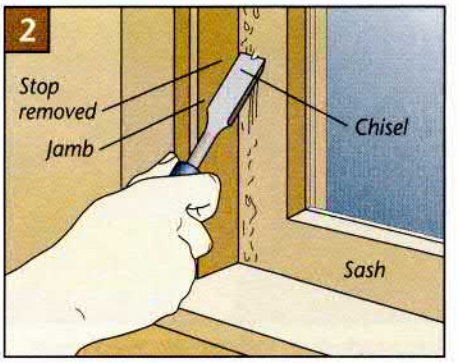


If the sash is too wide, remove it (page 56) and lightly sand each side. Check constantly for fit: sanding too much can result in a loose sash.

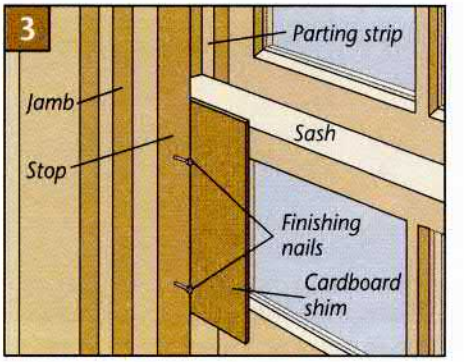
Repositioning the stops



Pry off stops (leave nails with them) after scoring the paint between jambs and stops (remove screws first if stops are screwed).



Chisel any built-up paint off the edges of the sash, stops, and parting strip. Sand the edges smooth and apply paraffin to them.



Nail the stops back on jambs, using a thin cardboard shim between the stop and sash as a spacing guide. Then remove the shim.

...DOUBLE-HUNG WINDOWS

Broken Balance Systems

When a balance system is broken, the window will not remain in position. The repair depends on the type of system—pulley and weight, spiral-lift, tension-spring, or cord—used in the window.

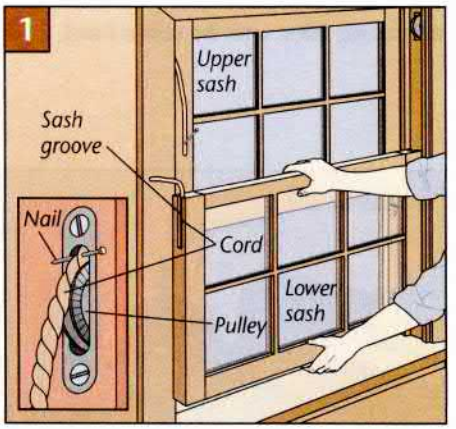
To repair or replace a balance system, you'll have to remove one or both sashes *(see below)*. If just the lower sash is affected, remove only that one. If the repair involves the upper sash, remove both. Be sure to take off any interlocking weatherstripping before removing the sash.

PULLEY & WEIGHT SYSTEM

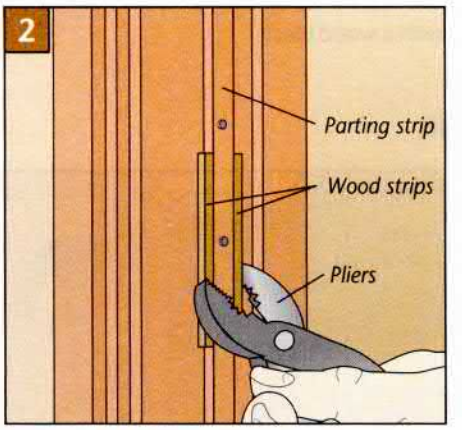
Pulleys and weights traditionally operate double-hung windows. The weights are suspended on cords or chains located behind the side jambs.

If you're replacing a broken cord, it's a good idea to replace all the cords in the window at the same time, preferably with long-lasting chains or nylon ropes, as shown below. To replace a defective chain, follow the instructions for cords. Before detaching the old chain, be sure to immobilize the weights on each side by drawing up the chains until the weights touch the

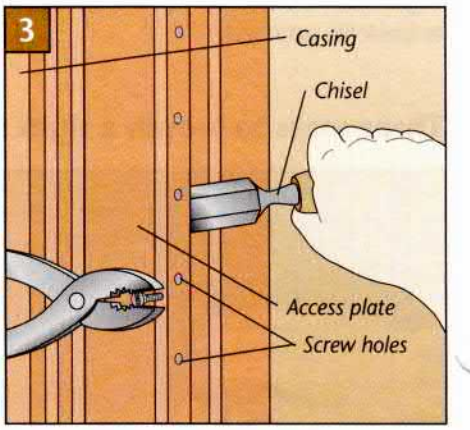
Removing wood sashes and replacing cords



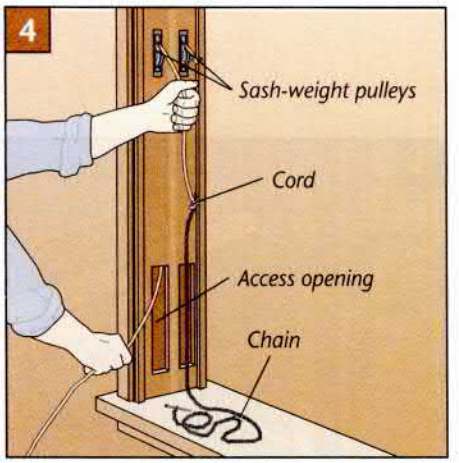
Angle the lower sash out after removing the inside stops *(page 55)*. Untie and slip each cord out of the groove (nail keeps cord from slipping through pulley).



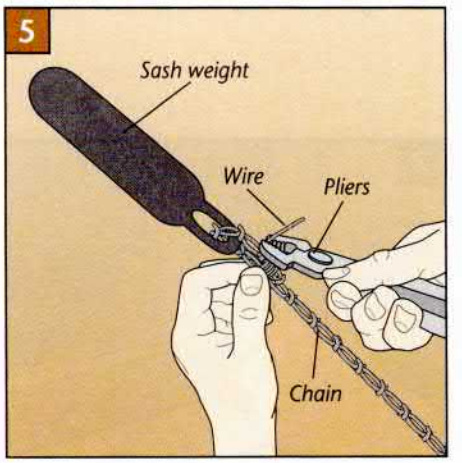
Pull out each parting strip with pliers (use wood strips to protect wood). Angle the upper sash out of the frame; disconnect the cords *(see Step 1)*.



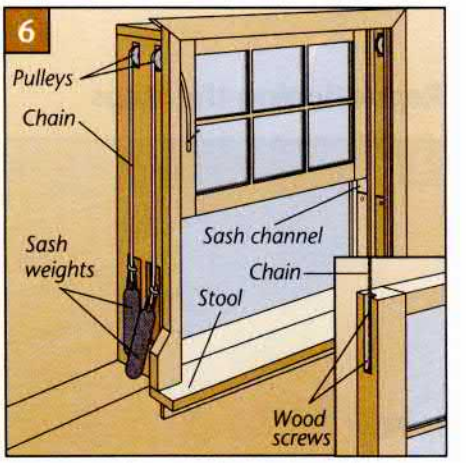
Remove the screws holding each access plate and pry the plates off to get at the sash weights. (If there are no plates, carefully remove the window's casings.)



Tape an end of each new chain to an end of each cord; slip a nail through each chain's other end. Untie the weights, then pull the cords out of the openings.



Loop each chain through the hole in each weight; secure the chains with wire. Clear the access openings of any debris and replace the weights.



Adjust the chains so the weights will be 2 inches above the stool when the sash is up. Secure the chains to the sash channels; replace the access plates.

pulleys. Slide a nail through a link at each pulley to hold the chains in place; then detach the chains from the sash.

Once the new chains are in place, replace the upper sash, parting strips, access plates, bottom sash, and stops, in that order, checking the operation of each sash as you go.

SPIRAL-LIFT SYSTEM

In a spiral-lift balance system, a spring-loaded spiral rod encased in a tube rests in a channel in the side of the stile. The top of the tube is screwed to the side jamb; the rod is attached to a mounting bracket on the bottom of the sash *(see illustration below)*. Each sash has two such units.

Adjusting the tension. With a spiral-lift balance, adjusting the spring tension may be all that's needed to make the window operate properly. If the sash tends to creep up, loosen the spring by detaching the tube from the sash channel and letting the spring unwind a bit. If the sash keeps sliding down, turn the rod clockwise a few times to tighten the spring. If this does not help, you'll need to replace the unit.

Replacing the unit. To remove a broken balance, pry off the stop on the affected side *(page 55)* and unscrew the tube where it's fastened to the top of the side jamb. Let the spring unwind; then raise the sash 6 to 8 inches and angle it out of the frame. If the rod is attached to the bottom of the sash with a detachable hook, unhook it; support the sash in a raised position with a wood block, then unscrew and remove the mounting bracket.

Position a new tube in the channel and screw it into the top of the side jamb. Pull the spiral rod down as far as it will go and turn it clockwise about four complete turns to tighten the spring. Let the rod retract into the tube far enough so you can fasten the mounting bracket to the bottom of the sash. Replace the sash.

Check the movement of the sash by sliding it up and down, and adjust the tension as described at left. Once the window is operating properly, reposition the stop *(page 55)*.

TENSION-SPRING & CORD SYSTEMS

In a tension-spring balance system, each window sash is operated by two balance units with spring-loaded drums inside; the units fit into the side jamb close to the top. A flexible metal tape hooks onto a bracket screwed into a groove routed in the sash.

A cord balance system, not shown here, is a variation of the tension-spring system. Two spring-loaded reel units fit into each corner of the top jamb. Nylon cords connect the units to each sash and plastic top and side jamb liners conceal the parts.

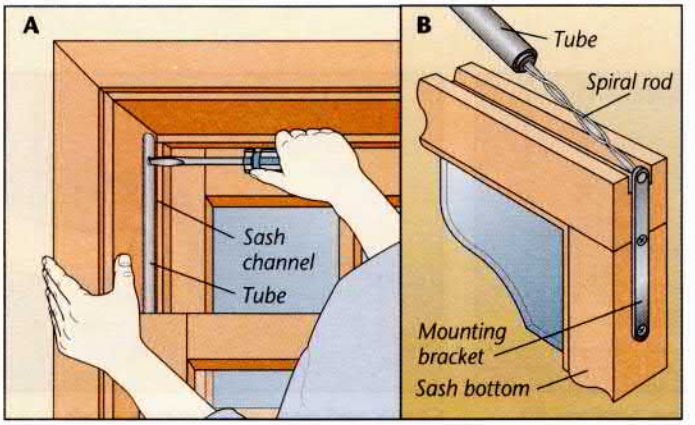
Replacing the unit. If any component of a tension-spring or cord balance system breaks, you'll have to remove the unit and install a new one. Instructions for replacing a unit are outlined below.

To remove a tension-spring unit, you must remove the stop on the affected side, as described on page 55, and ease out the sash. Unhook the tape from the bracket and let it wind back slowly on the drum. Remove the screws from the drum plate and pry the unit out of the jamb pocket.

Insert the new balance into the jamb pocket and secure it with wood screws. Using long needlenose pliers, pull the tape down and hook the end onto the bracket on the sash. Replace the sash, check its operation, and reposition the stop *(page 55)*.

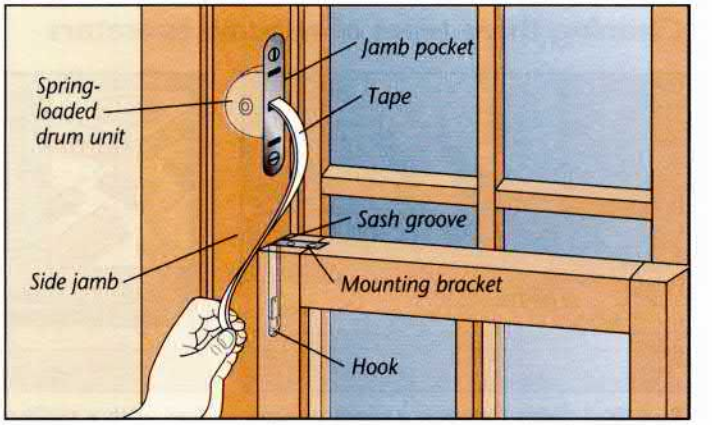
A cord balance unit is replaced in the same way as a tension-spring unit. You will need to remove the jamb liners first in order to remove the sash and then pry out the balance unit from the top jamb.

Replacing a spiral-lift unit



To remove the unit, unfasten the tube from the jamb (A) and remove the mounting bracket from the sash bottom (B). To install a new unit, attach the new tube to the jamb, tighten the spring, and fasten the new mounting bracket to the sash.

Replacing a tension-spring unit



To remove the unit, unhook the tape from the sash and let it wind back on the drum. Unscrew and remove the drum unit from the side jamb. Insert the new unit into the jamb pocket and screw it on. Pull down the tape and hook it to the sash.

CASEMENT WINDOWS

A casement window, whether made from wood, vinyl, or metal, has a sash hinged at the side and is operated either by a sliding rod (usually found in older windows) or by a crank and gear mechanism. A window made from metal or vinyl seldom experiences problems if the hinges, latch, and window operator are cleaned and lubricated regularly. Problems that could potentially develop include a faulty window operator and, with a window made from wood, a binding or warped sash.

REPAIRING A FAULTY OPERATOR

You can prevent most window operator problems with a simple maintenance routine. Occasionally clean the mechanism and lubricate it with paraffin, a few drops of light penetrating oil, or silicone spray. If a casement window resists opening or closing, follow one of the methods described below to get it back into working order again.

Sliding-rod mechanism. Look for hardened grease or paint on the sliding rod. Cleaning and lubricating the rod, channel (if any), and pivot points, as shown below, usually solves the problem.

Crank and gear mechanism. First try cleaning and lubricating the extension-arm track *(see below)*.

If the window still doesn't operate properly, check the gear assembly in the crank mechanism. To do this, you'll have to unfasten and remove the operator. Open the window partially and remove the screws that hold the operator to the frame. Slide the extension arm toward you until it slips free. Then pull the extension arm in through the window frame.

Inspect the gears; if the teeth are worn, replace the unit with an exact duplicate that cranks in the same direction as the old one.

If the gear teeth are still sharp but are clogged with dirt, remove any dirt or grease with a piece of stiff wire or clean the assembly with a solvent such as kerosene and let it dry. Lubricate metal gears with graphite powder, silicone, or petroleum jelly; then turn the crank several times to spread the lubricant. Use silicone spray on nylon gears. If the gears still malfunction, replace the entire assembly with a duplicate.

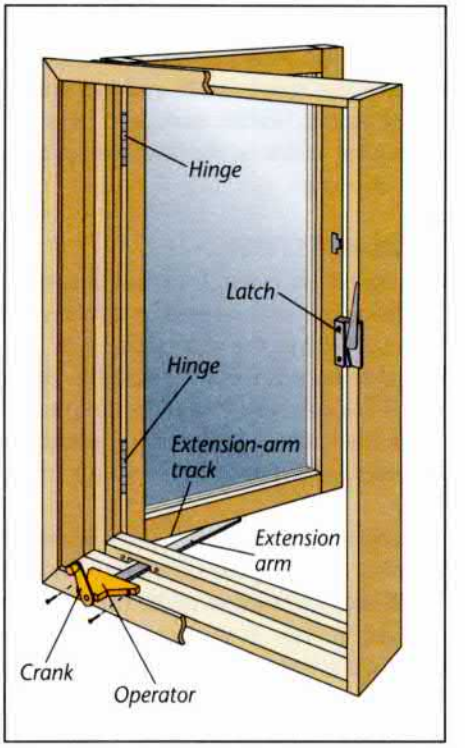
CORRECTING A BINDING SASH

If a sash sags or sticks, adjust the hinges as for a door *(page 67)*.

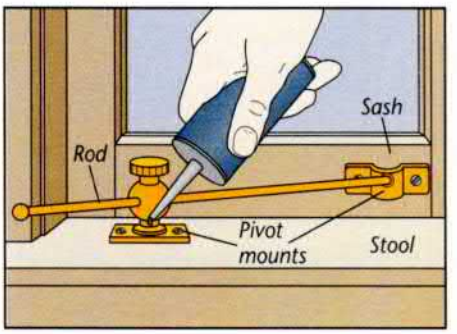
To fix a paint-bound sash, scrape away any excess paint and sand the surface smooth. If a wood sash has swollen, sand the part that's rubbing, and then seal and refinish it. If the stop has swollen, remove it, sand as necessary and reposition it *(page 55)*. Then seal and refinish it after sanding as with the sash.

A mild warp in a sash made from wood can be compensated for by adjusting the stops *(page 55)* or by adding weatherstripping *(page 64)*.

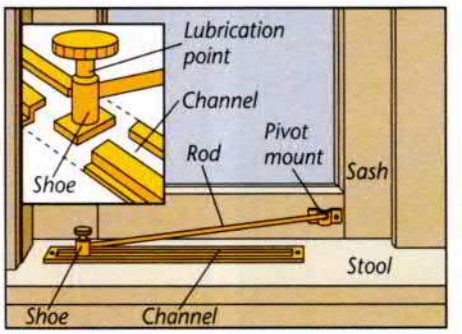
A casement window



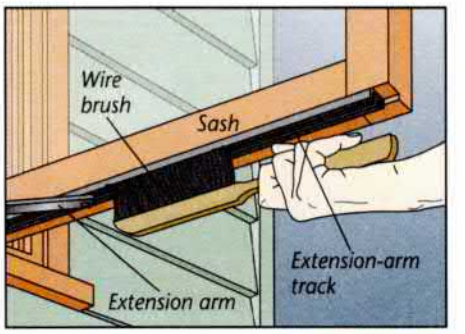
Cleaning three types of window operators



Rod that slides through a pivot mount. Remove any dirt or paint from the rod with steel wool; lubricate it with paraffin. Oil all pivot points and tighten the screws holding the mounts to the sash and stool.



Rod with a sliding shoe. Unscrew the channel and clean both the channel and stool. Lubricate the channel with paraffin and replace it. Tighten all the screws; oil all pivot points.



Crank and gear mechanism. Open the window and clean the track. Lubricate the inside of the track with petroleum jelly or silicone spray, removing any excess. Lubricate the operator.

SLIDING WINDOWS

Sliding-window sashes move along metal, wood, or vinyl tracks fitted into the window frame at the top and bottom. To ease their movement, large sashes often have plastic rollers attached to the top and bottom, or to the bottom only.

Paint sealing the sash to the frame, a dirty or bent track, or sticking rollers can cause the sash to stick or bind. The window can jam or not close properly if its catch is bent, loose, or damaged.

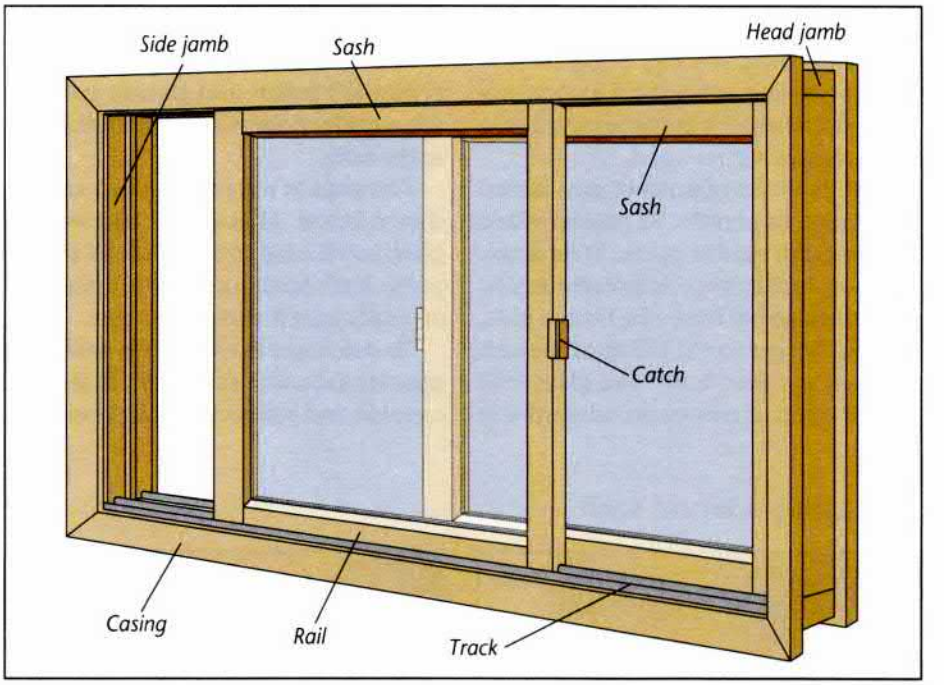
Freeing a paint-bound sash. If a sash is clogged with paint, score the edges with a sharp utility knife, then rock the sash from side to side to loosen it. Clean any dirt from the sides of the sash and the frame, and lubricate both with paraffin.

Cleaning and repairing a track. Use a wire brush to clean all the dirt from the track; for stubborn particles, use the blade of an old screwdriver to pry dirt loose. Lubricate the track with paraffin to keep the sash movement smooth.

Repair a bent track using the method shown below. You may need to remove the sash from the track before being able to make any repairs.

If the rollers are sticking, lubricate them with graphite powder or silicone spray until they move freely. If they're broken, you'll need to remove the sash *(see below)* and have a glazier replace the rollers.

A sliding window

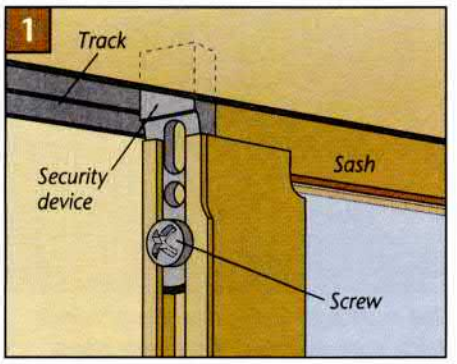


Repairing a catch. Sliding windows are secured with a variety of catches; the type used depends on the manufacturer and whether the windows are made from metal, vinyl, or wood. If the window's catch doesn't work properly, you may need to remove the sash from the frame, as shown below, to fix it.

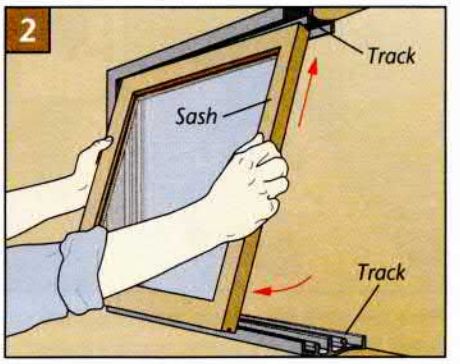
You may be able to reshape a bent catch. First note how much it will have to be reshaped. Then remove the catch and clamp it in a vise. Using pliers or a hammer, bend the catch to the proper angle. Replace it and check the latch operation: it should click as the window closes, and it should have to be depressed fully for the window to open.

Usually, the best solution is to replace a malfunctioning catch or one that is worn or broken with an exact duplicate.

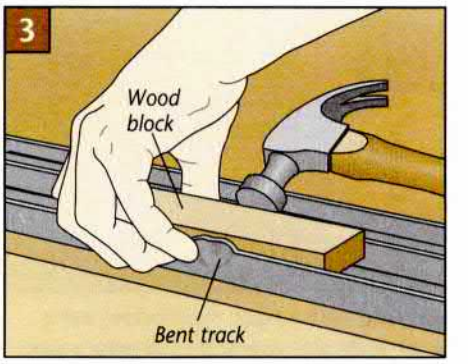
Straightening a bent track



To remove the sash, first look for any security devices at the top; loosen the screws holding them in place and remove the devices.



Carefully lift sash up to clear the track and angle the bottom edge out of the frame. Align the rollers with the key notches, if any.



Place a wood block in the track; using a hammer, tap the block against the bent metal until the side of the track is flat.

WINDOW GLASS

Replacing a pane—especially a small one—in a window sash isn't difficult. After carefully removing the old glass and measuring the opening, you can either cut new glass to size yourself or have it done professionally. Install it in the same way the original glass was installed.

CAUTION: Large panes of glass are too dangerous to handle. Be careful when working with smaller panes. Wear heavy gloves and safety goggles if you're removing shards. Before removing broken glass, tape newspaper to the inside of the sash to catch any fragments. Pad glass with several layers of newspaper when you're transporting it and dispose of glass fragments immediately.

Wood sashes. In wood sashes, tiny metal glazier's points and glazing putty on the outside of the window hold the glass in the sash.

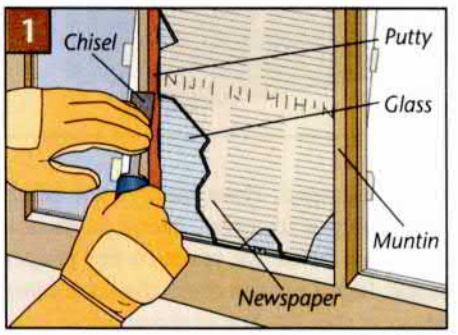
The steps in reglazing a wood sash are shown below. After you've removed the glass, you'll need to chisel out all the old putty. If it's hard, soak it with linseed oil or gently heat it with a heat gun.

To determine the size of the new pane, measure the width and height of the sash opening and subtract 1/8 inch from each dimension. Measure the sash at several points to allow for it to be out of square.

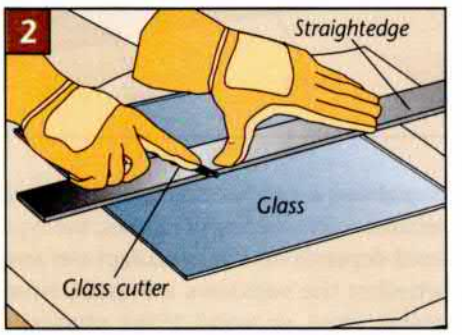
NOTE: Since wood sashes are reputtied from the outside, you may have to remove an upper-story window or get up on a ladder to reglaze it.

Metal and vinyl sashes. In these windows, glass is held in several ways. Metal or vinyl casement windows *(page 58)* may use glazing compound or a combination of glazing compound and metal spring clips. In other windows, glass is secured with rubber seals, rubber gaskets, or beveled metal or plastic snap-out moldings.

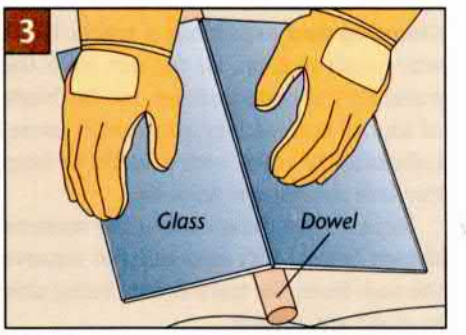
Reglazing a wood sash



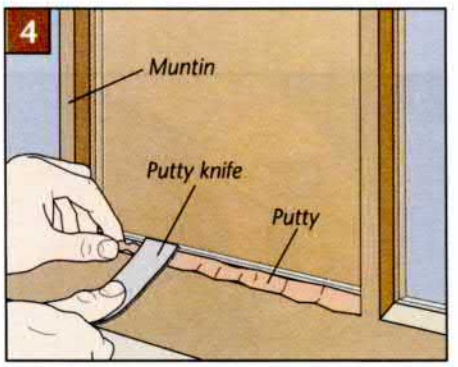
After removing large glass shards with gloved hands, chisel out remaining bits of glass and putty. Remove glazier's points with pliers. Clean and sand the wood; coat it with wood sealer.



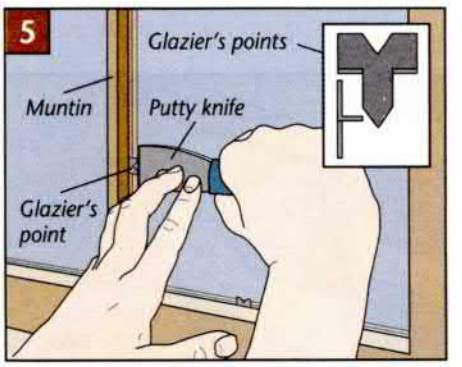
If the glass isn't precut, measure the window opening and cut the glass 1/8 inch smaller in each dimension. Place the glass on a carpeted bench top and score the glass deeply with a glass cutter (dip wheel in kerosene first).



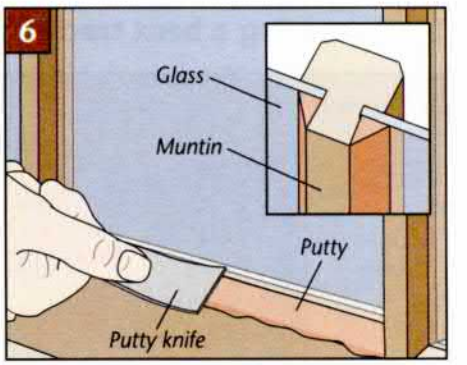
Place the score over a small dowel and press down on both sides (or tap the underside of the score with the ball end of the cutter). Using the notches on the cutter, nibble off any uneven pieces.



Working from outside the window, use a putty knife and your fingers to press a rope of glazing putty about 1/4 inch thick around the edges of the opening to make a bed for the replacement glass.



Press the pane into place; remove excess putty. Push glazier's points into the frame with a putty knife (use two points on each side for small panes and a point every 4 to 6 inches for larger ones).



Roll more putty into a rope about 1/4 inch thick; apply it around the outside edges. With a putty knife, smooth and bevel the putty to form a neat seal. When dry, paint to match the wood.

WINDOW SILLS

Window sills bear the brunt of snow, rain, and sun. Though they're designed to be tough, it's no wonder they show signs of wear. Annual maintenance—filling cracks with putty, caulking the edges, and repainting sills regularly—can prolong their life.

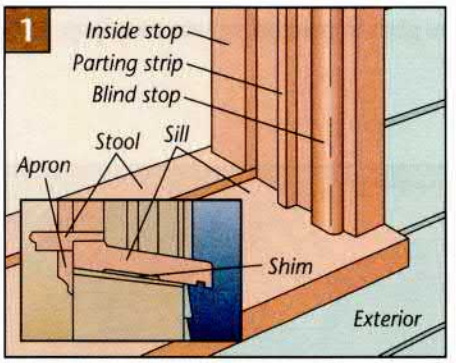
To restore a sill that's not badly damaged, clean out cracked or rotted wood with a chisel or old screwdriver. Then fill in any cracks or holes with wood or epoxy putty. If a crack or hole is very deep, build up the putty in layers, letting each layer dry completely.Then soak the sill with wood preservative. When dry (about 24 hours), coat it with linseed oil and let it dry. Prime and repaint the sill *(for painting tips, see page 42)*.

A sill can also be patched with epoxy patching material, which is pliable and waterproof. Where the wood rot is deeper than 1/4 inch, holes can be drilled to obtain deeper penetration. Apply it in temperatures between 55° and 75°F and let it sit for 24 hours before sanding and painting.

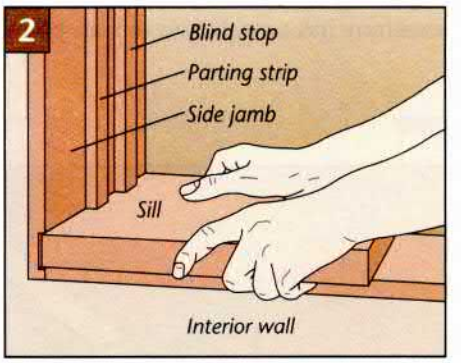
You can cover a badly damaged sill with a sheet of aluminum painted to match the wood if your concerns are purely function. First, build up the sill with putty. Cut a paper template that fits the sill top and wraps underneath it; use the template to cut out the aluminum. Caulk the edges of the sill; then butt one edge of the aluminum up to the stool and nail it to the sill. Move a block of wood over the surface, tapping it with a hammer to shape the aluminum around and under the sill. Nail the aluminum to the sill's underside; seal any gaps with caulking. Clean the aluminum and paint it.

Below are directions for replacing a severely damaged sill. Have a new one milled to match at a lumberyard or cut one yourself. Buy lumber that's pressure-treated with a preservative compatible with the paint or stain you plan to use.

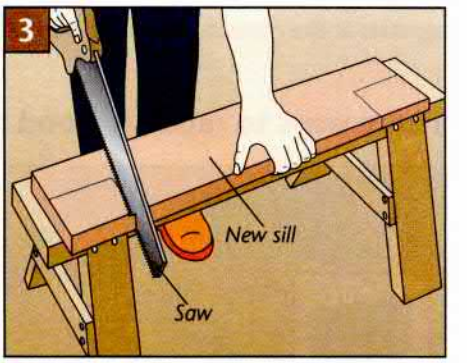
Replacing a window sill



Carefully pry off interior casings and inside stops *(page 55)*. Remove the sash *(page 56)* and pry off the apron. Remove any nails from the stool and take it out in one piece.

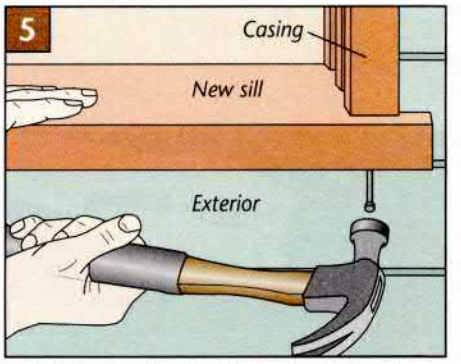


Measure the length of the sill between the jambs. Saw the sill into three pieces; remove the center piece, then the end pieces. Cut off any nails with the blade of a hacksaw.

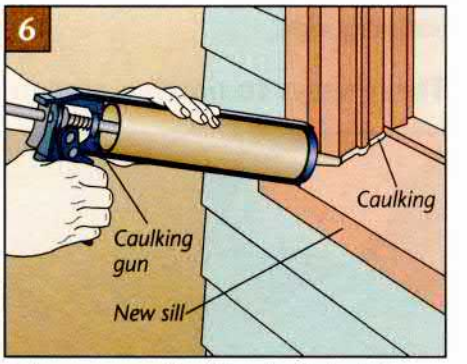


Mark the new sill to the correct length, allowing for any grooves in the jambs (use the old sill's end pieces as templates). Cut the new sill, beveling ends for an easier fit.

Tap the new sill into place, using a wood block to protect the edge. Don't force the sill; if it should stick, remove it and sand it lightly. Then try again.



Add shims under the sill for a snug fit, if necessary. To secure the sill, nail it to the side jambs from underneath and toenail it through the inside edge.



Sink any exposed nail heads, fill the holes, and seal the wood. Caulk the sill's edges and finish *(page 42)*. Replace the stool, apron, sash, stops, and casings.

WINDOW SCREENS & STORM WINDOWS

The window screens and storms in your home may be the kind you can remove or they may be aluminum-frame combination storm and screen windows you can leave in place year-round. The frames may be wood or metal, the screening metal (typically aluminum) or fiberglass.

With regular maintenance, your storms and screens should last for years. Clean screening periodically with a stiff bristle brush; apply thinned screen enamel, paint, or varnish to galvanized metal screening. Paint wood storm and screen frames when necessary to protect them from weathering. Clean aluminum frames with aluminum polish or steel wool and coat them with paste wax.

Mending a frame. If a frame begins to separate at the corners, you can reinforce the corners with metal reinforcing angles, corrugated fasteners, wood screws, or glued-in wood dowels *(see below)*.

Lay the screen or storm on a flat surface and clean out the gap in the joint. If the frame is in good condition clamp the frame to force the corners together and screw in a metal reinforcing angle.

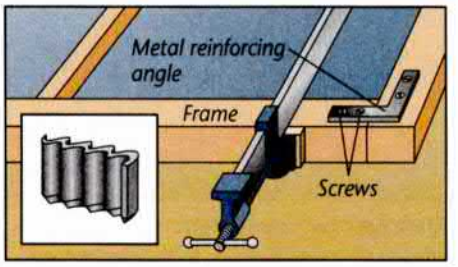
If the frame is still loose, attach corrugated fasteners at the corners or fasten with wood screws. To reinforce the corners with glue-coated dowels, clamp together opposite frame rails using a long bar clamp. Tap the dowel into a predrilled hole, as shown below. Only use glue to reinforce the corners of a window frame if you are gluing face-grain to face-grain.

Repairing or replacing screening. If the screening has a small hole or tear, patch it *(see below)* before the flaw gets any bigger. If your screening is made from fiberglass, you can fix a small hole by gluing a patch in place.

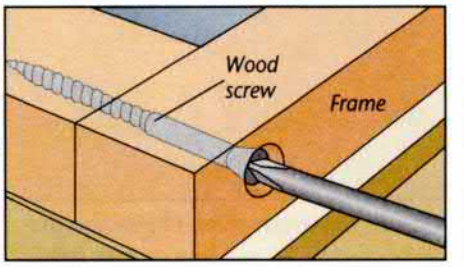
If the hole or tear is very large or if the screening is old and worn, it's best to replace it *(see facing page)*. To replace fiberglass screening in a wood frame, follow the instructions for replacing metal screening, but cut the screening with a razor blade and turn the edges under 1½ inches to form a hem. If you are replacing fiberglass screening in an aluminum frame, use a screen-spline roller to roll both the screening and the spline into the channel in one operation.

Replacing storm window glass. Glass in storm windows is replaced in the same way as glass in permanent windows *(page 60)*.

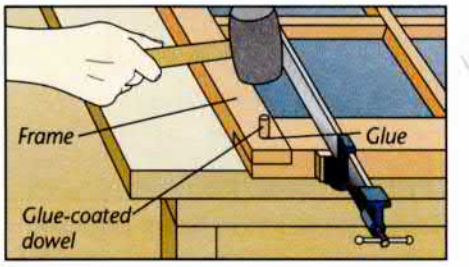
Three ways to repair a wood frame



Hold the frame's corners together tightly with a bar clamp on opposing frame rails. Hammer in a corrugated metal fastener (inset) or, for a stronger joint, screw in a reinforcing angle.

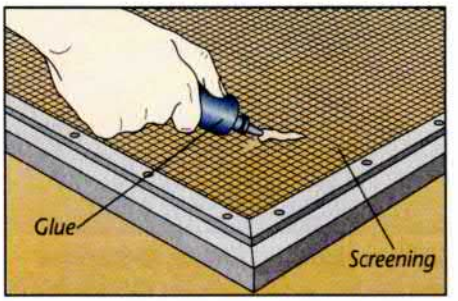


Glue the frame at the corner, then countersink a long wood screw through the corner joint. Cover the screw head with wood putty; sand and paint.

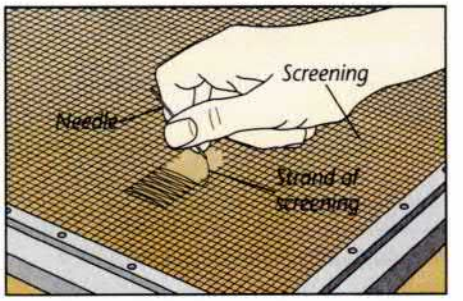


Drill a hole centered in the frame's corner (make it 5/16 inch in diameter and 1/4 inch shorter than the frame's thickness). Tap in a 5/16-inch-diameter glue-coated dowel.

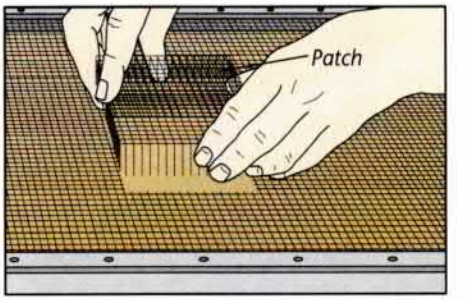
Three ways to patch a screen



Repair a very small tear in metal or fiberglass screening with epoxy or acetone-type glue. Layer the glue on until the tear is filled.

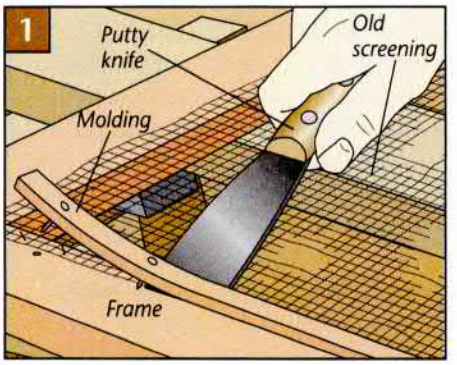


Repair a small hole by weaving or darning strands of screening into the tear. Weave the strands into sound fabric to close the hole.

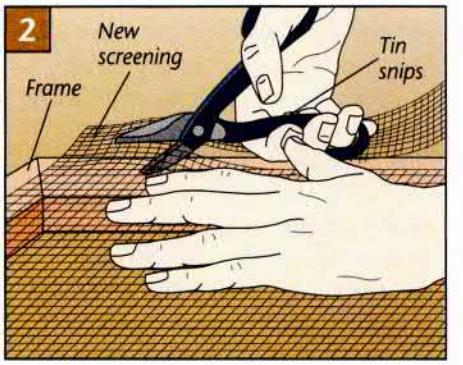


For a large tear, cut a patch larger than the tear. Unravel each side, bend end wires, and push them through to hold the patch.

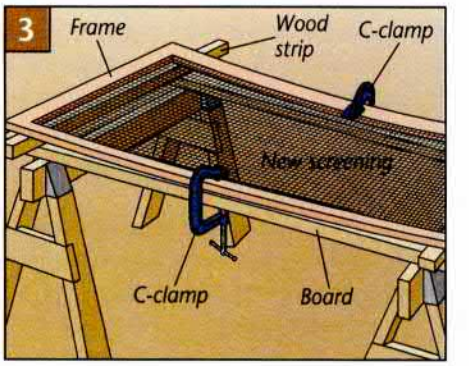
Replacing metal screening in a wood frame



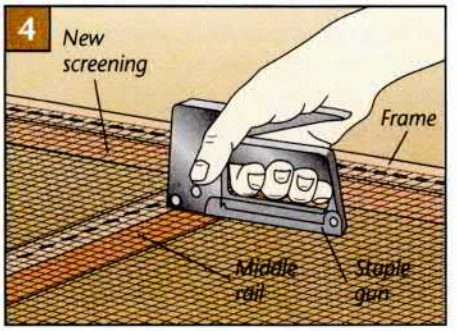
Carefully pry off the molding with a putty knife or chisel, working from the ends toward the center. Remove and discard the old screening (or save for making patches).



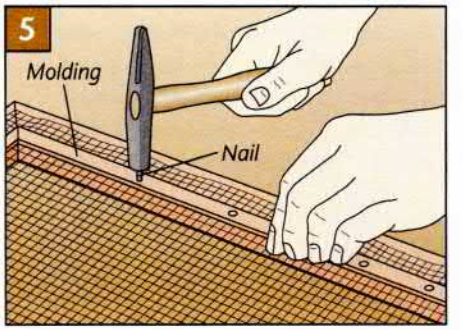
Using tin snips, cut a new piece of screening 2 inches larger than the opening on all sides. Staple the screening to one end of the frame so the staples will be under the molding.



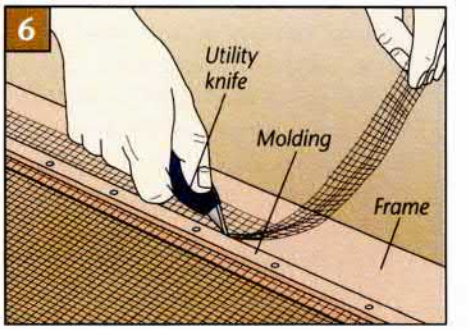
To bow the frame, place it on boards over sawhorses and put 3/4-inch-thick strips under the ends; clamp the middle. Staple the other end of the screening and remove the clamps.



Working from the center toward the ends, staple each side of the screening, pulling it tight. Staple the middle rail last.

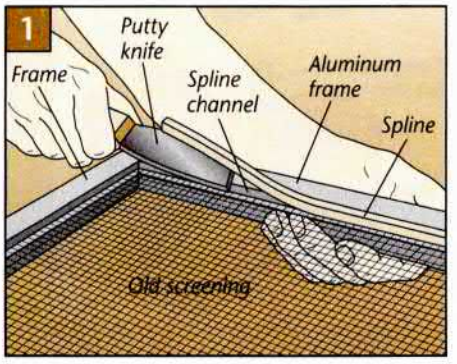


Nail on the molding. Countersink the nail heads and fill in any holes. (Refinish any new molding to match the frame.)

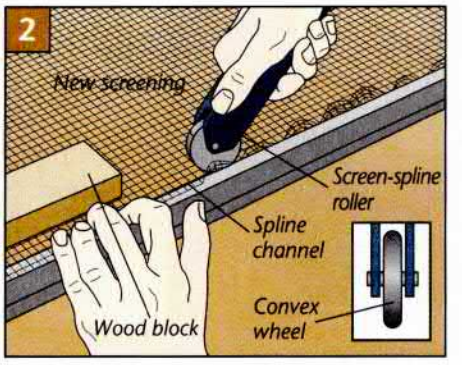


With a utility knife, carefully cut away the excess screening around the frame, using the molding as a guide.

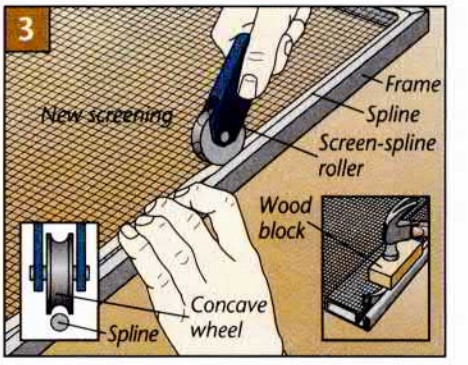
Replacing screening in an aluminum frame



Pry off the splines. Cut new screening the same size as the frame's outer dimensions, squaring the corners. Place the screening flush with the channel's outer edges on one end and side.



Bend the screening into the channel at the end of the frame, using the convex wheel of a screen-spline roller or a putty knife. Use a wood block or brick to weight down the screening.



Push the spline back into the channel, using the concave wheel of the roller or a wood block and hammer. Holding the screening edges tight, insert splines in the other end and sides. Trim any excess.

Weatherstripping Windows

Most windows manufactured now are weatherstripped at the factory. If your windows aren't weatherstripped, you can seal them yourself with weatherstripping. The three types generally available are spring type, pliable gasket, and compressible felt strips. Look for weatherstripping in a building supply store or home improvement center.

Spring-type weatherstripping made from bronze, aluminum, or stainless steel is slightly angled (spring-metal strips); made of vinyl, it is bent in the shape of a V (cushion-vinyl strips). You fasten it with nails to the window frame, except at the bottom where you nail it to the bottom of the sash.

Pliable-gasket weatherstripping is made from resilient material, such as vinyl, vinyl and foam, felt, or closed-cell sponge. This type of weatherstripping is either backed with adhesive or attached with nails; it should fit on the window stop so the sash presses lightly against it. Though not visible from the inside, the strips may be very noticeable from the outside.

Compressible felt strips are the least effective and durable type of weatherstripping, but they're useful in some situations *(see below)*. Some strips fasten with nails or glue; others are backed with adhesive.

Double-hung windows. Spring-type weatherstripping is best for a double-hung window *(page 54)*. Though it's more difficult to install than pliable gasket, it's more durable and less visible. Install the weatherstripping in the channels, on the top of the upper-sash top rail, on the bottom of the lower-sash bottom rail, and on the side of the upper-sash bottom rail where the sashes meet.

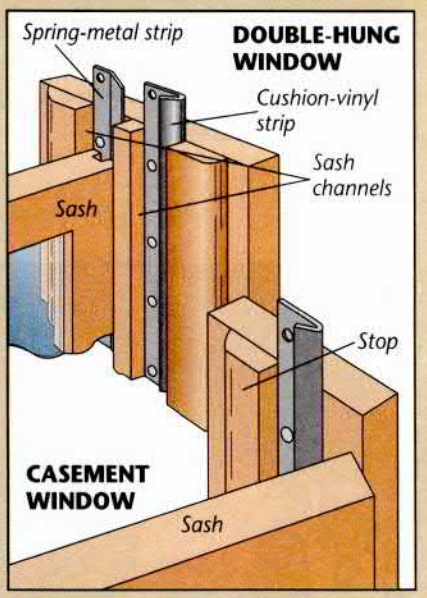
Casement windows. Pliable-gasket weatherstripping works well on wood casement *(page 58)* and other hinged windows. Cushion-metal weatherstripping can also be used on wood casement windows. Some metal casement windows can be weatherstripped with a special spring-metal strip or vinyl gasket (these must be special-ordered).

You can attach compressible felt strips to the frame of a metal or wood casement window where the sash meets the stop and frame. Though the strips wear out quickly, they're good for a warped window that doesn't close tightly.

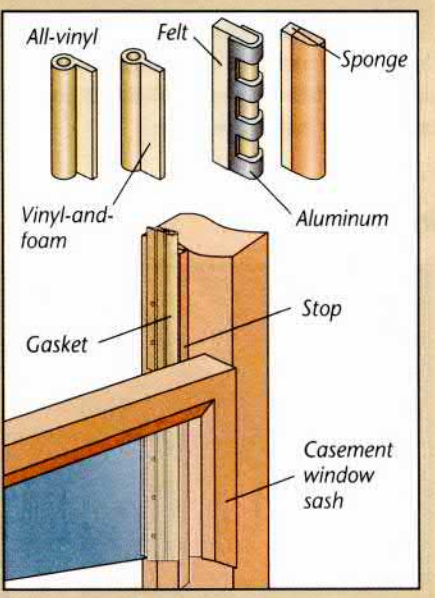
Sliding windows. For sliding windows with wood sashes *(page 59)*, install pliable-gasket weatherstripping along the outside top and bottom of the frame. If only one sash moves, use pliable-gasket weatherstripping along the side of the fixed sash and spring-type weatherstripping in the channel where the movable sash closes against the frame.

If both sashes move, install pliable-gasket weatherstripping where each sash fits against the side of the frame and between the two sashes so it forms a seal where they meet.

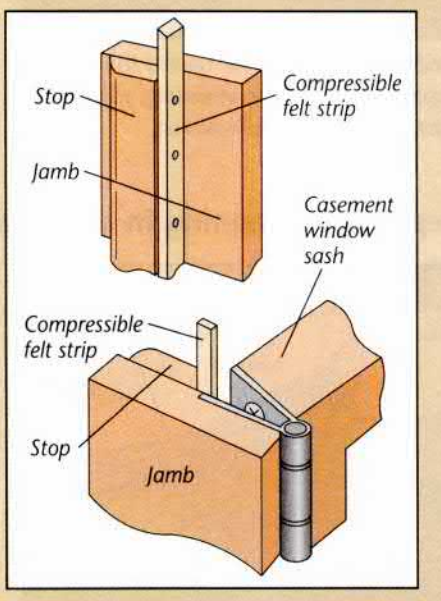
Three types of window weatherstripping



Spring-type weatherstripping fastens to the frame of a double-hung or casement window. After installation, the flange is pried up for a tight fit.



Pliable-gasket weatherstripping is adhesive-backed or attached with small nails. Fasten it to the stops so the sash presses lightly against it.



A compressible felt strip (used on metal or wood casement windows) is nailed or glued to the stop. On the hinge side, it's glued to the frame.

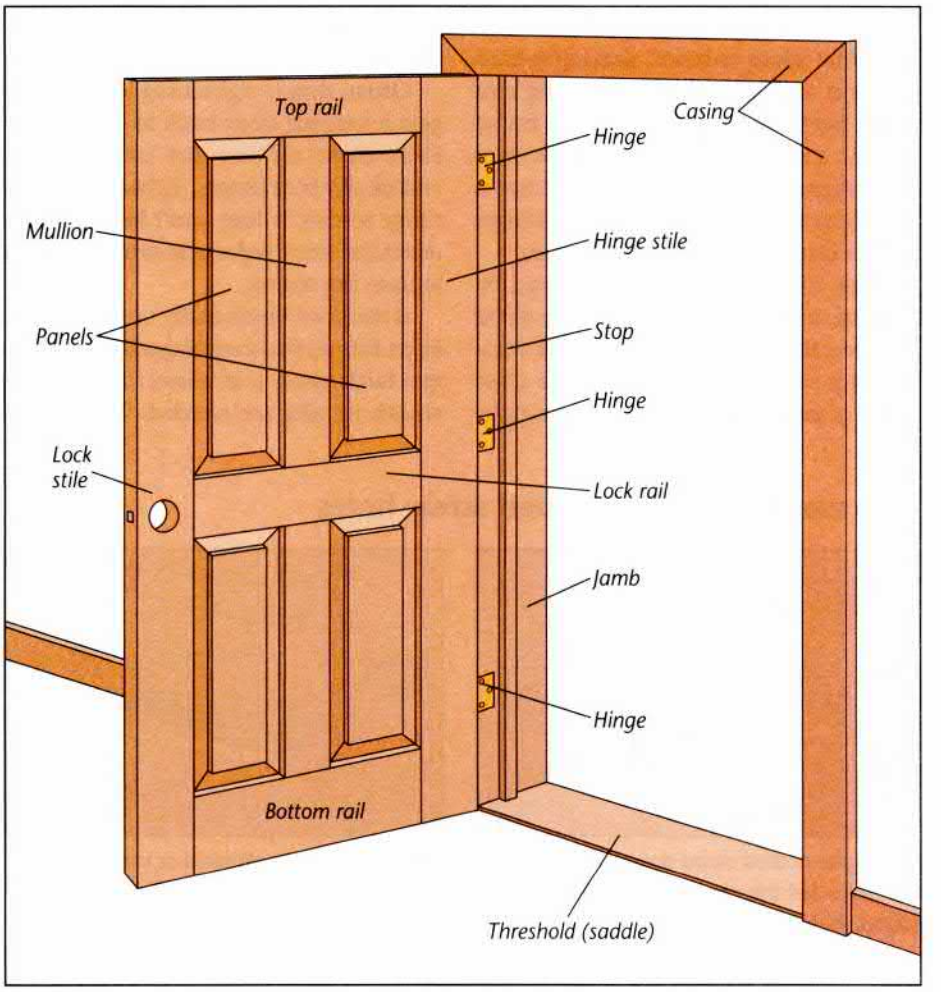
HINGED DOORS

All hinged doors have the same basic framework, sometimes hidden under a solid veneer. The framework consists of two stiles, which run vertically, and two or more rails, which run horizontally. The hinges are on one stile; the latch and lock are on the other. The two types of wood doors are paneled and flush. A paneled door has a visible frame of stiles and rails that supports two or more panels. If multipaneled, as shown here, the door has mullions and extra rails.

A flush door is faced with hardboard, wood veneer, metal sheathing, or a fiberglass composite. A flush door for exterior use should have a solid core of several layers of hardwood, foam-insulation fill, or particleboard; an interior flush door usually has a hollow core formed from a frame surrounding a grill-like structure.

The door has two or three hinges that attach it to the frame. The frame consists of jambs, casing, stops, sill, and threshold. The jambs form the sides and head of the frame; the casing acts as trim and as support for the jambs. The stops are wood strips the door fits against when closed. In exterior doors, a sill fits between the jambs, forming the frame bottom. The threshold, or saddle, and sometimes a weatherstrip are fastened to the sill.

A typical hinged door and frame



REPAIRING A DOOR

Age and continual use can cause even a well-fitted door to loosen, bind, or warp. Often, the latch no longer works properly. Fortunately, correcting these problems is usually fairly simple. But a door that's badly warped will have to be replaced *(page 69.)*

Loose doors. If a door is too small for its frame, an easy solution is to install weatherstripping. If a loose door is causing latch problems, you may be able to adjust the latch.

Binding doors. Binding or sticking results from a number of causes, from a buildup of dirt and paint to a door that sags. Adjusting the fit of the door usually solves the problem *(see page 66).*

Warped doors. If the warp is minor, you may be able to adjust the stop or hinges to compensate for it. See page 67 for more information.

Latch problems. When a latch refuses to work, the trouble may be with the fit of the door or with the lockset *(page 76).*

REMOVING A DOOR

Removing a door is not always necessary for making a repair. If you're working on just one hinge at a time or on the top of a door, you need only open the door partially and drive a wedge underneath the latch side to hold the door steady. But for other repairs, such as sanding or planing the side or bottom of a door, you'll need to remove it from its hinges and lay it on a workbench to effectively do the repairs.

To remove the hinge pins, close the door securely (place a wedge under it or have a helper hold the door). Using a hammer and a nail, gently tap on the bottom of the lowest pin or on the underside of its head to drive it up and out of the hinge barrel. Remove the middle pin, if any, then remove the top pin. Lift the door off its hinges.

When you reinstall the door, replace the top pin first, then the middle and bottom ones. Drive the pins home only after the hinges are correctly aligned. Leave the pins a little loose so they'll be easier to remove for future repairs.

...HINGED DOORS

Binding Doors

A common and annoying problem is a door that sticks or binds, making it hard to open and close easily. Binding can result from house settlement (the frame moves), a buildup of paint or dirt, or from a misaligned or sagging door. The cure is usually to adjust poorly set or loose hinges and/or sand or plane the door edges.

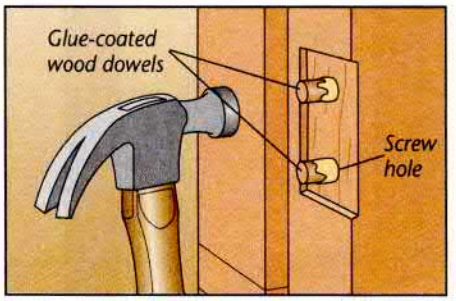
First, identify the spots that bind by inserting a thin strip of cardboard or wood between the door and jambs. Look for a buildup of dirt and paint on the door edges or jambs. Chisel off any large globs of paint and sand the surface. Coat the door edges and the jambs with paraffin.

Often, simply tightening loose hinges gets a sagging door back in alignment. First, clean off any dirt and repair or replace any bent hinges. Tighten any loose hinge screws. If they can't be tightened, repair the screw holes as shown below and replace the screws.

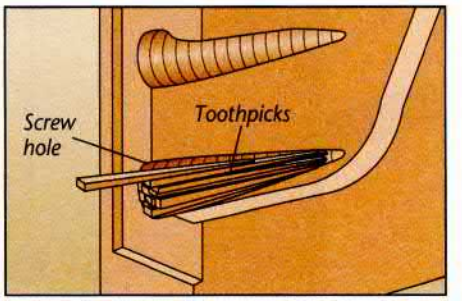
If the door binds badly or isn't square in its frame, you can diagnose the problem fairly easily *(see below)* to determine which repairs are needed. The hinges may have to be shimmed or set in deeper mortises *(page 68)*. Deepen the mortises as a last resort since getting the right depth can be tricky.

If you must remove excess wood from the door edges, sand with coarse, followed by finer, sandpaper. Keep the sanding as even as possible. Plane only if necessary. When sanding or planing the stiles, concentrate on the hinge side since the lock side is usually beveled to allow for a tight fit. *(For information on using a plane, see page 68.)*

Two ways to repair stripped screw holes



Drive glue-coated wood dowels or pegs into the holes. Let the glue dry; trim off excess wood. Redrill the pilot holes.



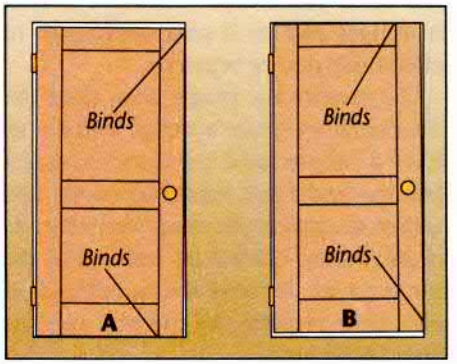
Pack holes with toothpicks or matchsticks coated in glue as a quick fix for lightweight doors. Replace screws with longer ones.

QUICK FIX-UP

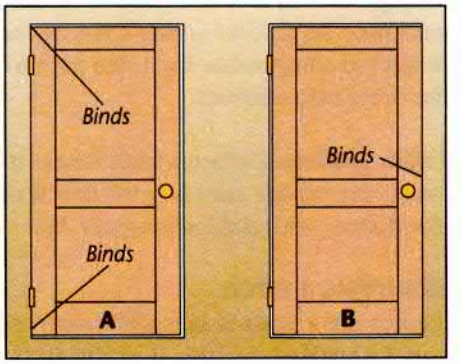
QUIETING SQUEAKY HINGES

Silence a noisy hinge by coating it with silicone spray or light penetrating oil. If the squeak persists, remove the pin and thoroughly clean the pin, barrel, and hinge leaves with steel wool. Coat them lightly with silicone spray or light penetrating oil and replace the pin.

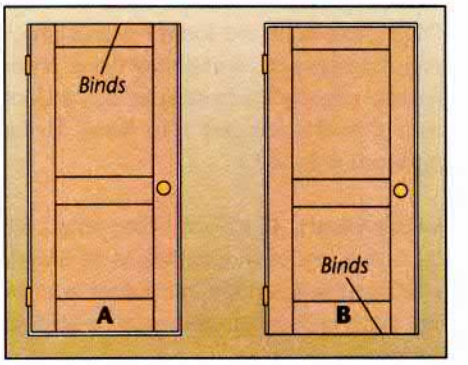
Diagnosing and adjusting a binding door



If the door binds as in (A), reseat the upper hinge (repair the screw holes and tighten the screws or deepen the mortise) and/or shim out the lower hinge. If the door binds as in (B), reverse the procedure.



If the door binds on the hinge side (A), shim out the hinges or remove the door and sand or plane the hinge side. If it binds on the lock side (B), sand or plane the lock side and deepen the mortises for the hinges.



If the door binds along the top (A), wedge it open and sand or plane the wood along the top. If it binds along the bottom (B), remove the door and sand or plane the wood along the bottom.

Adjusting a Warped Door

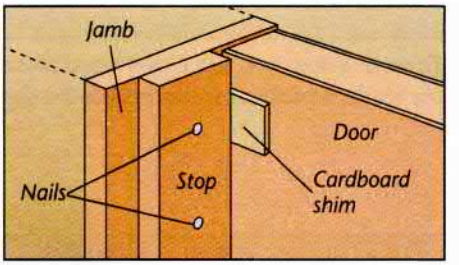
The best insurance against warping is to seal the door on all surfaces to prevent moisture from swelling and changing the shape of the wood. You may be able to fix a slightly warped door by adjusting the stop, partially shimming the hinges, or adding a hinge. A badly warped door should be replaced *(page 69)*.

Where there's a slight bow on the hinge side, centering a third hinge between the top and bottom ones often pulls the door back into alignment.

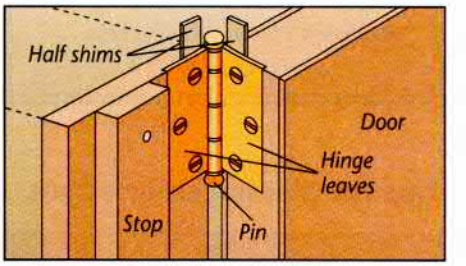
If the bow is near the lock side and the door latches only when slammed, first try adjusting the latch *(page 69)*. Then try removing and repositioning the stop as for a window *(page 55)*. If necessary, adjust the strike plate *(page 69)*.

If the top or bottom of the door does not meet the stop on the lock side, try repositioning the stop and the strike plate. You may also have to shim the hinges to change the angle of the door's swing. Place a half shim, as shown below, under each hinge leaf either on the side of the leaf that's closest to the pin or on the opposite side (depending on the warp). Usually, the other hinge is shimmed in the opposite way, on the side of the leaf furthest from the pin.

How to adjust a warped door



Reposition the stop (page 55), spacing with a thin cardboard or wood shim; nail the stop in place.



Adjust the angle of a door by placing a half shim of cardboard or thin wood under each hinge leaf, as described above.

Techniques for Working on Doors

Techniques for repairing a door include planing the edges, cutting or deepening hinge mortises, and making shims for hinges. To make these repairs, you may have to take down the door and support it on edge while you work.

Supporting a door. One way to support a door while you're working on it is to set it on edge, and pad and wedge one end into a corner of the room.

A better method is to build two door jacks *(page 68)* and set the door on edge into them. The door's weight will bend the plywood strips and press the 2-by-4 wood blocks against the door like a vise.

Planing a door. Don't be in a hurry to start planing. When only a small amount of wood must be removed, sandpaper wrapped around a wood block *(page 20)* is the best choice.

When you must plane, use a plane that's long enough to ensure flat cuts; the blade should be wider than the thickness of the door so the cuts will be level. Though a jack plane (14 to 15 inches long) is preferable, a 9- to 10-inch-long smoothing plane will do the job.

To avoid gouging the wood, plane with the grain. Adjust the blade *(page 19)* to make paper-thin cuts so you don't remove too much wood *(see page 68 for tips on planing a door)*.

If you're working on a binding door *(page 66)*, plane the top or bottom rail if the door is binding there, or the hinge stile if the door binds on the hinge side. It's best to avoid planing a binding lock stile, since it involves maintaining the beveled edge along that side and, in some cases, repositioning the lockset. Instead, plane the hinge stile whenever possible to correct the problem.

You'll need to remove the hinge leaves before planing. Use a utility knife to cut through any paint around the leaves; then unscrew and remove the hinges. After you plane, deepen the hinge mortises, as explained at right. If you must plane near the top or bottom of the lock stile, be sure to re-form the bevel after planing.

Cutting hinge mortises. Hinge mortises are recesses into which hinge leaves are fitted so they sit flush with the door or jamb surface. You'll need to cut hinge mortises *(page 68)* if you're adding a middle hinge to straighten a warped door or if you're hanging a new door. If you're adjusting the position of the door in a jamb or you've planed the hinge stile, you'll have to deepen the mortises. To deepen a mortise, mark the new depth on the edge of the door or jamb; then go to Step 3 at bottom right on page 68.

Making shims. To move a door closer to the lock side of the jamb, you can insert a shim under the hinge leaves. Use thin sheet brass (available in several thicknesses) or dense, hard-surfaced cardboard (such as that used in file folders).

Using a hinge leaf as a pattern, cut a shim and make the screw holes. (The shim should be minutely smaller in each dimension than the hinge.) Don't glue the shim in place; you may want to remove it later on.

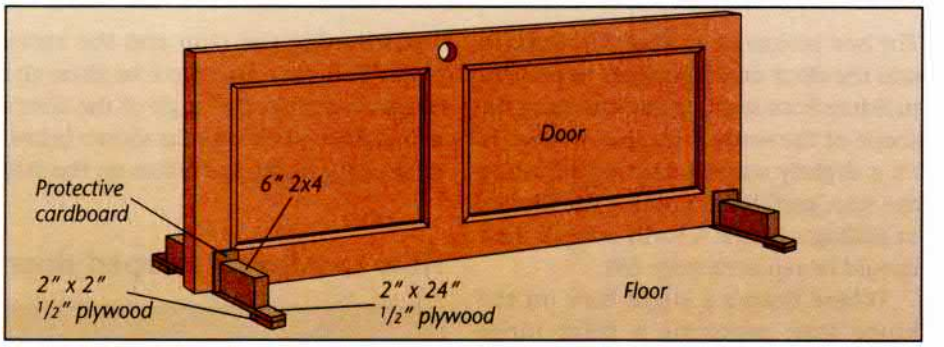
...HINGED DOORS

PROFESSIONAL TIPS

USING A PLANE

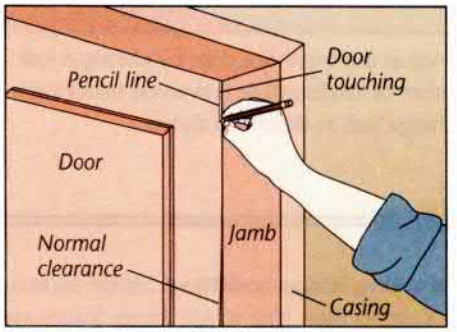
Use two hands when operating a jack plane, gripping the rear handle with one hand, the front knob or one edge with the other. At the beginning of the cut, apply slightly more pressure on the plane's toe; even out pressure as you continue the stroke, then near the end gradually switch pressure to the heel.

Supporting a door

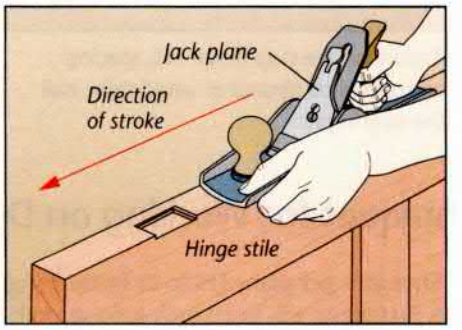


To make a door jack, nail 2-by-4 wood blocks to strips of plywood. The clearance between the blocks should just accommodate the door and the protective cardboard.

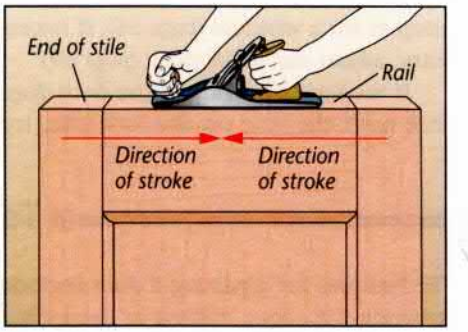
Tips for planing door edges



Carefully mark the area to be planed on both faces of the door before removing it from the hinges. Keep a close eye on your marks as you plane.

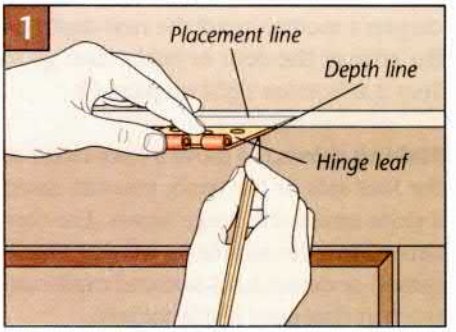


Plane the stile, using long strokes with the plane parallel to the stile; cut with the grain. If you're planing the lock side, be sure to re-form the bevel.

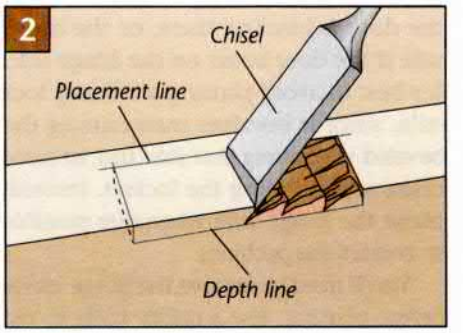


Plane the top or bottom of the door by cutting from each end toward the center. This will avoid splitting the ends of the stiles.

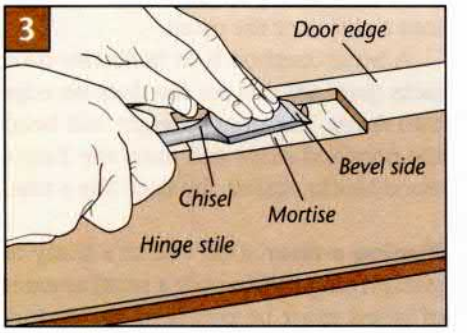
Cutting a hinge mortise



Using the hinge leaf as a template, mark the placement and depth lines for a new hinge or a depth line for a deeper mortise; then score the hinge mortise with a hammer and chisel blade. If you're simply deepening a mortise, go to Step 3.



Make shallow, parallel cuts to the desired depth, using a hammer and chisel held almost vertically. Then lower the chisel to a 30° angle, the bevel side down, and without using a hammer, chip out the wood to the desired depth.



Make the final smoothing cuts from the side, holding the chisel bevel side up, almost flat. Position the hinge leaf and, for a new mortise, check that it's flush with the surface of the door or jamb. Mark and drill pilot screw holes.

Adjusting Balky Latches

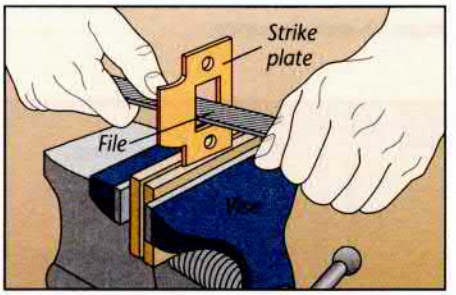
If a door latch doesn't catch or won't operate smoothly, the latch bolt on the door may not be lined up properly with the strike plate on the door jamb. Repairs range from minor latch adjustments to repositioning the door itself.

If the latch's operation isn't smooth, lubricate the latch with graphite. If it does not catch, close the door slowly to watch how the latch bolt meets the strike plate. The bolt may be positioned above, below, or to one side of the strike plate. (Scars on the surface of the strike plate may give you a precise clue to the degree and direction of misalignment.) The problem also could be that the door has shrunk and the latch no longer reaches the strike plate.

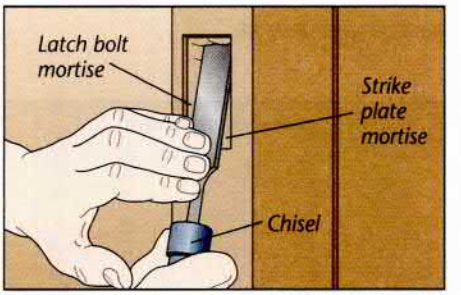
Once you've determined the adjustment needed, use one of the three methods illustrated below to remedy the situation. Or, if the door has warped only slightly, adjust the angle. To do this, you can either insert half shims on the side of each hinge leaf that's closest to the pin, angling the door inward, or reposition the stop closer or further from the door so the latch can engage the strike plate *(see repairs for warped doors, page 67)*.

If the lock is causing the problem, turn to page 74 for information on lock repairs.

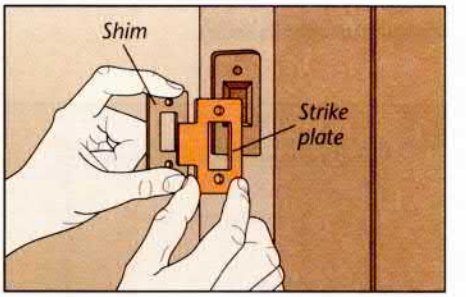
Three ways to adjust a strike plate



For less than a 1/8-inch misalignment of latch bolt and strike plate, remove the strike plate and file its inside edge to enlarge the opening. (You may also need to extend the bolt mortise.)



For more than a 1/8-inch misalignment, remove the strike plate and extend the mortise higher or lower as needed. Replace the plate, fill the gap at top or bottom with wood putty, and refinish.



If the latch doesn't reach the strike plate, shim out the plate or add another strike plate. If the latch still won't reach, shim out the door's hinges. Replace the door with a wider one, if necessary.

Replacing a Door

Hanging a replacement door *(page 70)* takes a lot of patience. Adhering to the tips listed below and following the steps in order will make the work go faster and more smoothly.

You can fit a new door to an existing frame *(page 70)* or buy an easy-to-install prehung unit that comes with frame, door, and hardware, all fitted and ready to install. Both types of doors are available at building supply stores and lumberyards.

Before purchasing a replacement door, remove the old door and measure the opening from top to bottom on both sides. Then measure across the opening at two or more points; check the upper corners with a steel square. Doors, particularly hollow-core ones, have only a 1/2-inch trim margin, so be sure the replacement door you purchase will fit your opening.

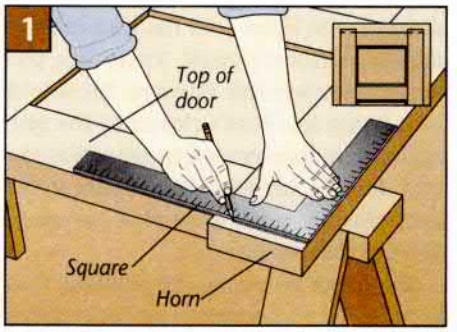
CAUTION: Be sure to double-check all measurements before cutting.

Here are a few points to keep in mind when hanging a door:

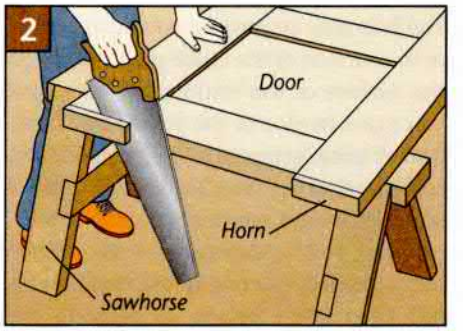
- Sand or plane any excess wood up to 1/16 inch on the door's top and bottom, up to 1/4 inch on the sides. Saw off any excess that's greater; then sand.
- Leave a 1/16-inch clearance around the door on the top and sides. Bottom clearance should be at least 1/2 inch more if you need to clear a rug.
- Bevel the lock side of the door 1/8 inch so the door will clear the jamb as it opens and closes. If the door is already beveled, install it so the beveled edge is on the lock side.
- When installing a hinge on the door itself, leave at least a 3/8-inch margin between the edge of the door and the hinge-leaf edge.
- If you're hanging a new door into an existing frame *(page 70)*, use the existing hinges if possible. If you can't use them or must move them, follow Steps 6-7 and the instructions for making a hinge mortise on page 68.
- Place the top hinge about 7 inches below the top of the door, the bottom one 11 inches above the bottom of the door. If you're installing a third hinge, which will give the door better balance, center it between the two others.

...HINGED DOORS

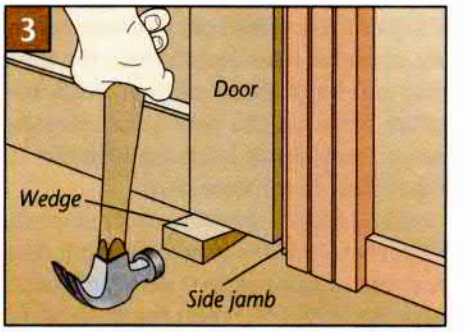
Hanging a replacement door



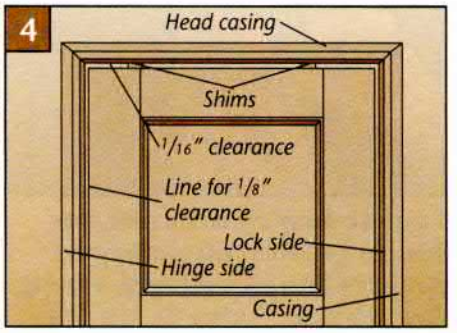
If the replacement door has horns, mark them to be cut off flush. If the opening isn't square, mark the door itself to fit, being careful not to exceed the door's trim margin (usually 1/2 inch).



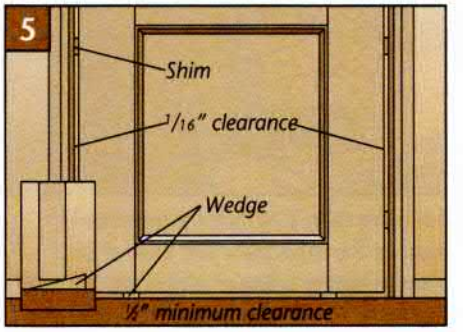
Rough-trim the new door. Prop the door in the opening to make sure it fits. If the opening isn't standard size, make any additional cuts on the door that are necessary for it to fit.



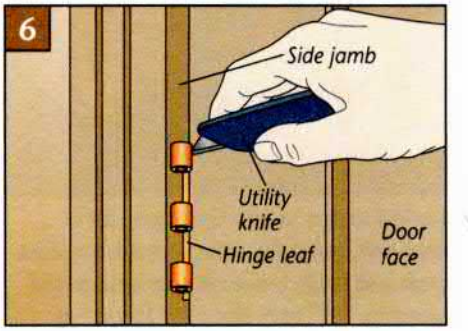
Place the door in the opening and shim at the top for a 1/16-inch clearance; insert wedges under the door to hold it in place. Mark and cut the bottom, leaving a minimum 1/2-inch clearance.



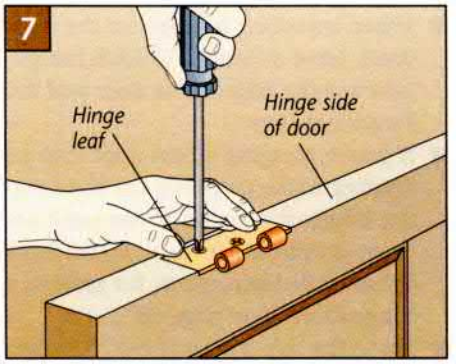
Wedge the door snugly against the lock side, maintaining the 1/16-inch top clearance. Mark a trim line for a 1/8-inch clearance on the hinge side and then trim. Bevel the lock side if necessary.



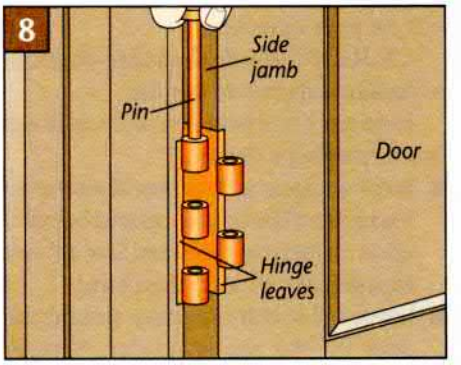
Hold the door in position with shims and wedges, and double-check the clearances—1/16 inch on the top and sides, a minimum of 1/2 inch on the bottom. Lightly sand where it is needed.



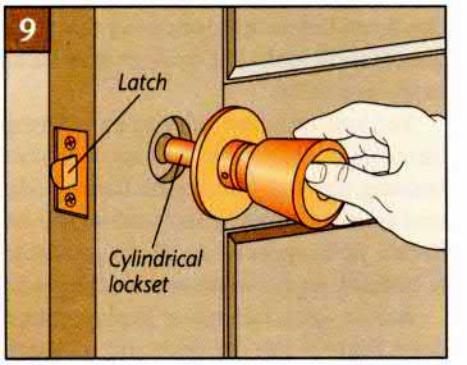
Remove the hinge-side shims and push the door tightly against the hinge jamb. Mark the hinge locations on the door with a utility knife, using the hinge leaves on the jamb as guides to aid you.



Outline the hinges, using the marks made on the door. Cut the mortises with a hammer and chisel *(page 68)*. Position the hinge leaves in the mortises, drill pilot holes, and insert the screws.



Start the top pin through the barrel and position the door. Insert the middle and bottom pins. Wiggle the door until the pins slip in. Check to make sure the door fits, trimming if necessary.



Install the new lockset *(pages 75-77)*. Take the door down and seal all surfaces with a sealer or primer to prevent swelling and warping later on. Finish the door and replace it on the hinges.

DOOR THRESHOLDS & SILLS

The thresholds inside your house and the sills and thresholds in exterior doorways are the hardest-working parts of your doors. Because they're exposed to continual foot traffic and, in the case of exterior doorways, the elements, both may eventually need to be replaced.

The sill forms the bottom of the frame of an exterior doorway and serves the same function as a window sill—it diverts water away from the door and house. The sill fits snugly under the casing and against or under the jambs.

Fastened to the sill is a threshold, which helps seal the air space under a door. Thresholds are often used inside as well to make a neat transition between different flooring materials.

Thresholds, also called saddles, are available in either hardwood or metal (usually aluminum). You can also get special thresholds that act as weatherstripping *(page 78)*.

Removing a threshold or sill. Remove a damaged threshold or sill very carefully so you don't damage the door frame or, in the case of a sill, any flashing underneath. If necessary, you can cut them out, as shown for window sills on page 61. Unscrew and remove a metal threshold. Be sure your replacement is long enough and measure carefully before making any cuts.

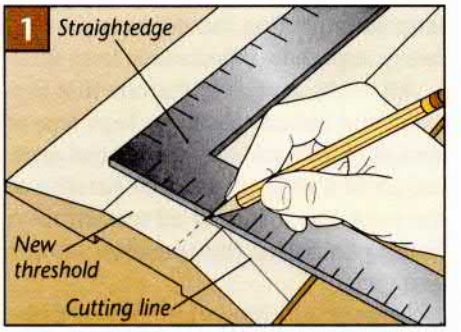
Installing a new threshold or sill. Check that the clearance between the bottom of the door and the new threshold is about 1/8 inch. If it's less, mark the bottom of the door using the new threshold as a guide, and sand or trim the door to fit. For installation instructions, see at right.

If adding weatherstripping at the door bottom *(page 78)*, follow the manufacturer's recommendations for clearances.

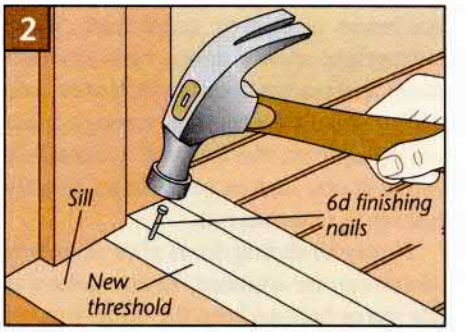
Once a wood threshold is in place, sink the nail heads and fill them. Sand the threshold smooth and coat an interior one with clear varnish or sealer. Fasten a metal threshold with screws.

Be sure to finish a sill and threshold in an exterior doorway to protect the wood against the elements.

Replacing a wood threshold

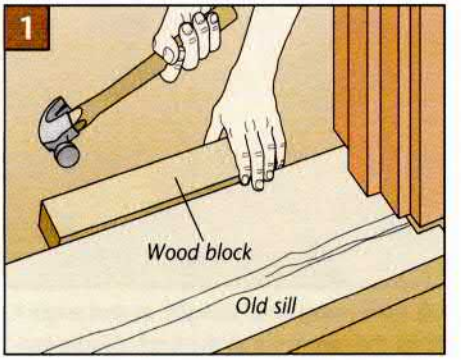


Mark the new threshold to fit between the jambs; cut, notching the ends to fit around the stops. Sand all cut edges. Caulk the underside and ends; center it under the door.

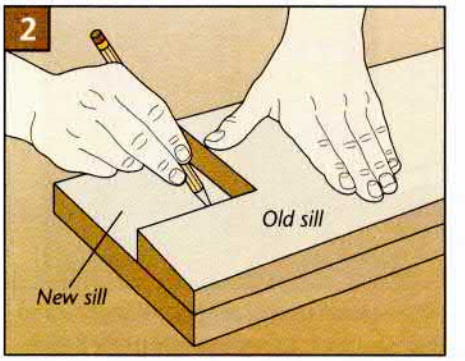


Nail the threshold to the sill with 6d finishing nails (predrill the holes). Countersink the nail heads and fill the holes with wood putty. Finish the threshold as desired.

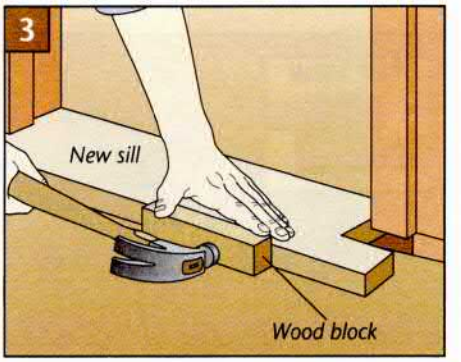
Replacing a sill



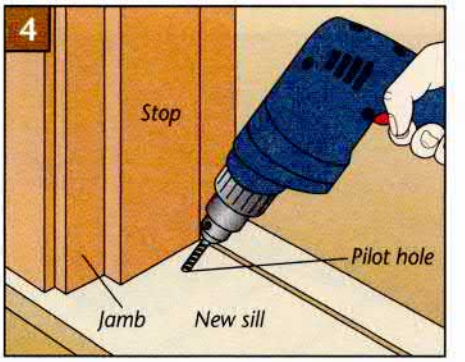
Drive out the old sill (or saw it into three pieces and remove the center, then the ends) after removing any nails. Take care not to damage any flashing underneath.



Using the old sill as a template, mark and cut the new sill to fit (if the old sill isn't in one piece, fit it together and make very accurate measurements before cutting).



Gently tap the new sill into place, being careful not to force it. (A wood block protects the sill from dents and splitting.) Sand or trim the sill for a snug fit.



Drill pilot holes for nails or screws after shimming the sill for fit, if necessary. Secure the sill, sink the nail or screw heads, and fill the holes with putty. Finish.

SLIDING DOORS

All sliding doors operate in basically the same way, though the variety of their hardware is almost unlimited. Some lightweight sliding doors, such as closet doors and pocket doors (which slide into walls), and extremely heavy garage doors are hung from the top rail. Moderately heavy doors, such as patio doors, usually rest on the bottom rail.

Nearly all sliding doors glide on rollers which can be adjusted. Plastic guides at the top or bottom keep the doors vertical and aligned with their tracks.

Removing a sliding door for maintenance or repair is simple *(see below)*, but keep in mind that the door can be very heavy, especially when made from glass.

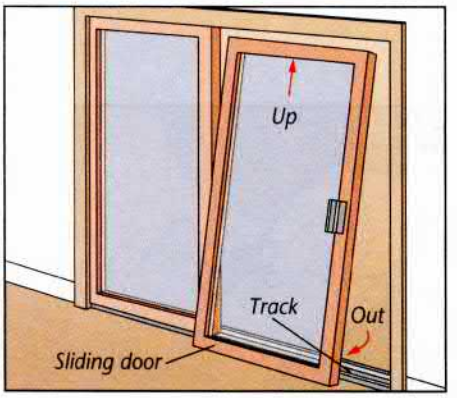
All tracks, especially the one that supports the rollers, must be kept free of foreign objects and dirt. Occasional application of a little graphite or paraffin to the track and a drop of oil to each roller bearing help keep the operation smooth and quiet.

Inspect all hardware periodically. Tighten any loosened screws in the frame or track and replace any part that's worn, broken, or missing.

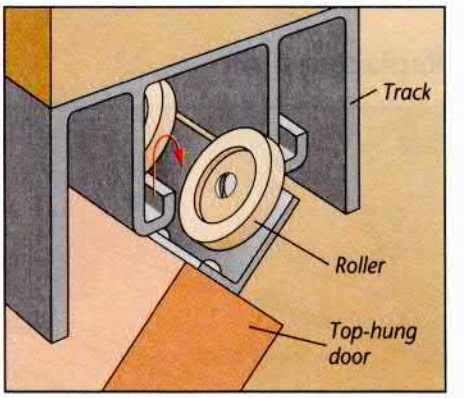
If a door jumps off its track, check for a dirty track, a section that's worn or bent, or a guide that's out of alignment *(see below)*. A door tilted in its frame usually needs roller adjustment (there should be a 3/8-inch clearance between the bottom of the door and the floor or rug).

Compensate for a minor warp in a door by adjusting the rollers to make the door higher or lower. If a door is badly warped, you'll need to replace it.

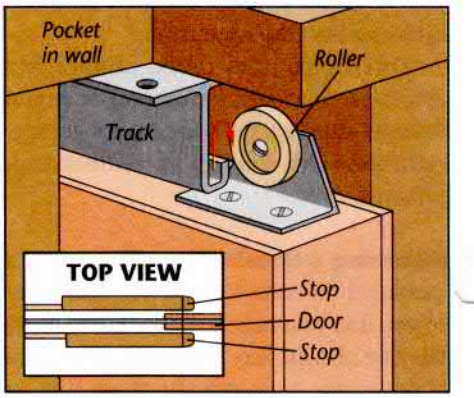
Removing three types of sliding doors



Lift a bottom-supported door straight up to clear the track; to remove it, sharply angle the lower part of the door outward. You may need a helper to hold the door since it can be heavy.

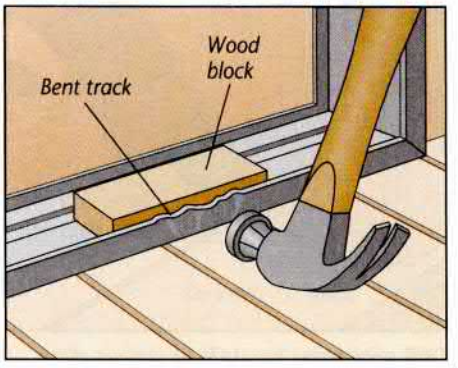


Lift a top-hung door straight up and angle it to lift the rollers out of the track. (Some top-hung doors have notches on the track that you must align with the rollers before you can lift the door out.)

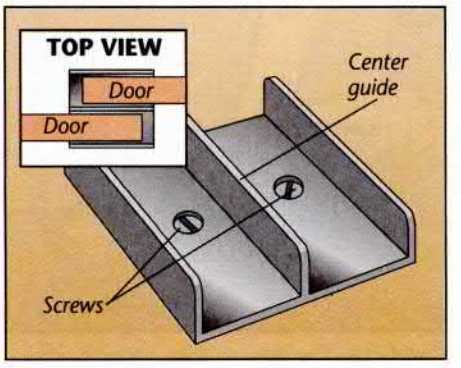


On a pocket door, remove both stops from the head jamb and one side-jamb stop to allow the door to swing out. To remove the door, angle the bottom out, then carefully lift it up.

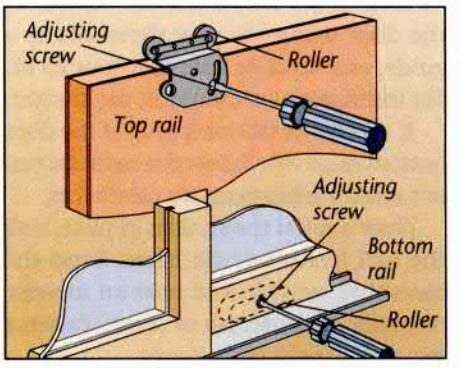
Three sliding-door adjustments



Use a hammer and wood block to straighten a bent metal track. Replace a badly bent or broken track.



Check the alignment of the guide if the door binds. Reposition the guide so the door doesn't catch on it.



Adjust the roller height at both ends of a tilting or dragging door until the door is correctly aligned.

STORM & SCREEN DOORS

Storm and screen doors are hung outside your home's exterior doors. Storm doors have an upper panel of glass and a lower metal or glass panel; a crossbar divides the panels. The frame is usually made from aluminum or steel. Screen doors may have an aluminum or wood frame with metal or fiberglass screens. Popular now are combination doors—screens are fitted into the door for summer use and are replaced with glass panels in winter.

All storm and screen doors should be equipped with a door closer—either a simple chain-linked snubber or a pneumatic or hydraulic type *(see at right)*. The closer ensures that the door closes smoothly and protects the door from being opened too wide or with too much force.

Like storm and screen windows, doors are subject to problems with their frames, glass, and screens. Door closers may also require adjustment, as described below.

Maintenance and repair. Maintain and repair your screen doors in the same way as window screens *(pages 62-63)*. Keep the hinges of both screen and storm doors oiled and tight, and lubricate the door closers once a year. Check that the latches work well.

Replace hardware, glass *(page 60)*, and screens as necessary. In addition, replace the clips holding the screens and glass in place if they become bent, broken, or lost.

Replacement parts are usually available at building supply centers and hardware stores. Because each manufacturer's hardware may be slightly different, be sure the replacement part will fit your particular door.

Adjusting door closers. The simplest type of closer is a snubber; it attaches to the head jamb and the top rail of the door. You can adjust the length of the chain if the door opens too wide or not wide enough.

A pneumatic closer attaches to the door and the hinge jamb. The closing speed of this type can be simply adjusted by turning the adjustment screw in the end cap. A hold-open washer can be positioned on the rod to prop the door open.

A less common type of door closer, usually found on outside doors, is the hydraulic closer. Some types fit only a right-handed or a left-handed door; others can be adjusted for either type of door by inserting a screwdriver in the adjustment screw, pushing in, and turning the screw 180°. A slight adjustment to the same screw changes the door's closing speed.

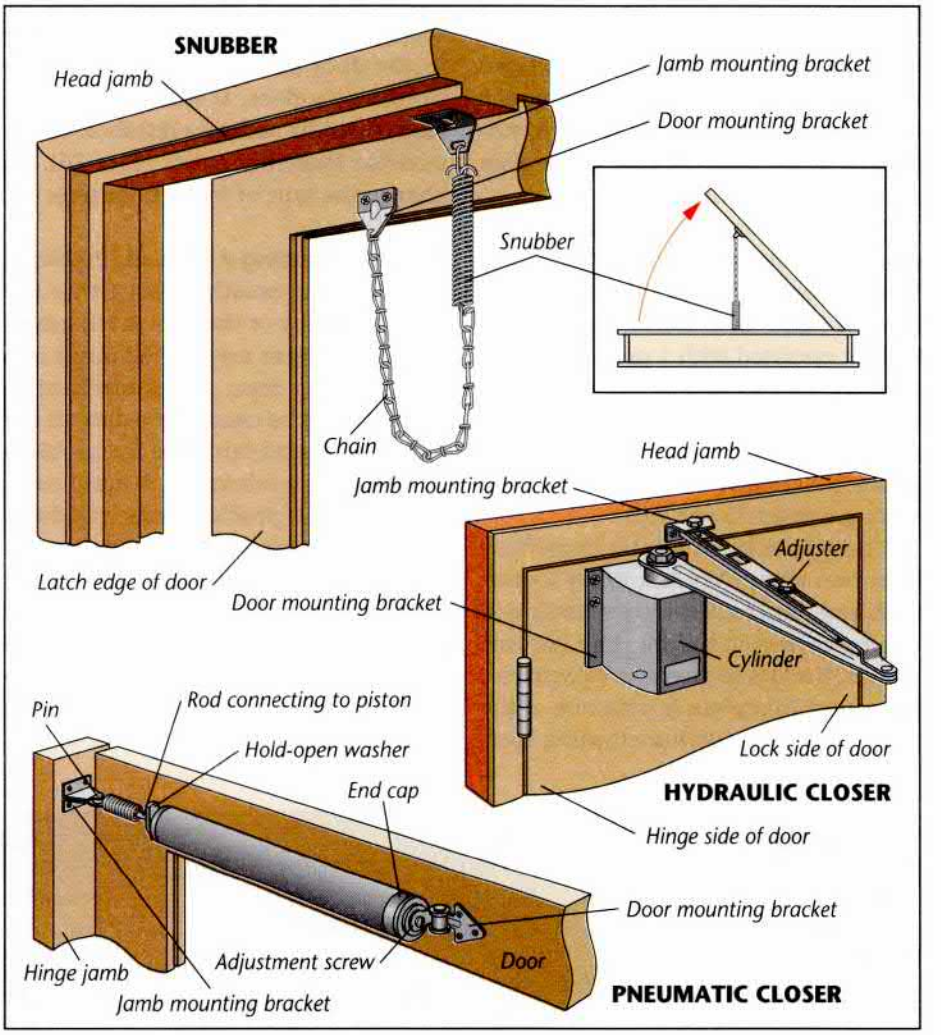
Installing a door closer. Installing a closer is fairly simple. Before you begin, check that the door operation is smooth and that the door hardware is in good working order.

If you're installing a snubber, fasten the door mounting bracket to the door's top rail and the jamb mounting bracket to the head jamb. Adjust the length of the chain as necessary.

For a pneumatic closer, install the door mounting bracket on the door's top rail, mount the closer in the bracket, and fasten the jamb mounting bracket to the hinge jamb; then adjust the closing speed.

To install a hydraulic closer, attach the door mounting bracket and the cylinder to the top rail. Then fasten the jamb mounting bracket to the head or side jamb and adjust the closing speed.

Three common door closers



DOOR LOCKSETS

Most locksets for doors fall into two categories, depending on the way they're installed. One type, encompassing cylindrical, tubular, and rim locksets, fits into a hole bored into the door's face; the other type, a deadbolt lockset, is surface-mounted onto the edge of the door and the door frame.

Most exterior doors have a cylindrical, rim, or mortise lockset. Some also have a deadbolt lockset *(page 76)*. Interior doors have either a cylindrical lockset operated with a push button or a tubular lockset, similar to a cylindrical one but simpler and less rugged. An older home may have keyless interior rim locks. *(For examples of cylindrical and rim locks, see pages 75 and 77.)*

Though locksets require immediate attention when they fail, many lockset problems tend to develop gradually and can be corrected before they become serious. If a lockset needs to be replaced, it's easiest to replace it with one of the same type. For a malfunctioning mortise lockset, first look for replacement parts. If it must be replaced, buy an exact duplicate that will fit the mortise in the door exactly; otherwise, you'll need a new door. If security is a concern, consider adding a deadbolt to the exterior lock that exists *(page 76)*. To change the type of lockset, see page 75.

Troubleshooting a lockset. Problems with locksets usually affect either the latch assembly or the lock mechanism. A latch problem may be the result of a poorly fitting door. A lock mechanism problem may be caused by a dirty or dry lock. Often, you can solve the problem by applying a lubricant. A more complicated lock problem may call for a locksmith or for a replacement lock.

Solutions to a range of common problems appear in the chart below. If your problems require professional help, keep in mind that removing the lock and taking it to a locksmith is far less expensive than having the locksmith come to you.

Replacing a lock. Often, it's simpler and less costly to replace the entire lockset, as shown on pages 75-77, than to try to fix it. You can buy rim locksets for exterior doors as well as cylindrical and tubular locksets at building supply centers, hardware stores, and some locksmiths. You can convert a cylindrical or tubular lockset to a deadbolt lockset by increasing the size of the holes in the door and jamb.

If possible, take the old lockset with you when you're buying a new one. If you can't, you should have the following information:

- Type of lock—cylindrical, tubular, or rim.
- Diameter of the cylinder and latch holes or the size of the rim.
- Backset measurement (distance from the edge of the door to the center of the doorknob).
- Thickness of the door (most locks are designed for standard doors).
- Direction the door opens.

Solving lockset problems

Problem	Possible Cause	Remedies
Latch sticks or responds slowly	Gummed up or dirty lock	Blow a pinch of graphite into lock or keyway; or inject light penetrating oil or silicone spray
Key doesn't insert smoothly	Dirty keyway and tumbler area Foreign object in keyway	Blow a pinch of graphite into keyway (don't use oil) Dislodge object with thin, stiff wire
Lock is frozen	Accumulated moisture frozen solid	Chip ice away; carefully heat key with a match; insert key in lock and work it gently until ice melts
Key is broken in lock	Improperly inserted key, ill-fitting replacement key, or wrong key forced into lock	Remove broken key with thin, stiff, hooked wire or remove lock cylinder and push key fragment out from other side with thin, stiff wire
Latch bolt doesn't engage or disengage easily	Door loose on hinges or otherwise misaligned	Correct any door problem and make any adjustments required to align latch bolt and strike plate *(page 69)*
Latch bolt doesn't extend fully into strike plate	Shrunken wood in door Shallow mortise or misaligned strike plate	Shim out hinges *(page 67)* or strike plate *(page 69)* or both; deepen mortise *(page 68)* or reposition strike plate *(page 69)*
Key won't turn in lock	Cylinder turned in face plate Poorly duplicated key Damaged tumblers	Move cylinder to proper position *(page 75)* Check key against original; replace if necessary Replace cylinder or entire lockset *(pages 75-77)*
Key turns but doesn't operate locking mechanism	Broken lock mechanism	Repair or replace lockset *(pages 75-77)*

Cylindrical & Tubular Locksets

Cylindrical locksets, commonly found in houses built since approximately 1960, are operated by a key inserted into the exterior knob; the interior knob is operated either by a small push or turn button on the knob or by a key inserted into it.

Tubular locksets are similar in construction to cylindrical ones. The major differences between them are that tubular locksets are simpler and have smaller locking mechanisms.

Removing a faulty cylindrical lockset and replacing it with a duplicate, as shown at right, is a job you could do yourself. (You remove and replace a tubular lockset in the same way.) See page 74 for more information on buying a replacement.

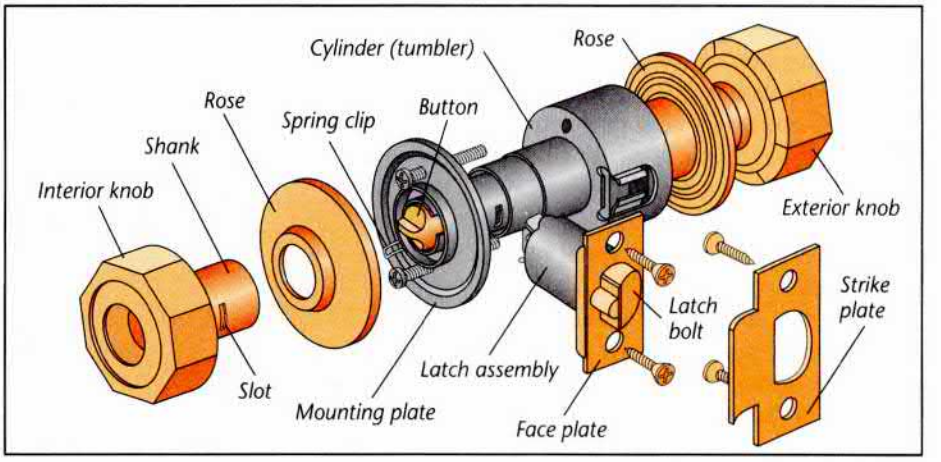
When you're installing a new lockset, make certain the new face plate and strike plate are flush with the door edge and all door jamb surfaces. If they are not, you'll need to adjust the mortises by chiseling out a shallow mortise *(page 68)* or by building up a deep one with wood putty.

Changing types of locksets. Though it's easiest to replace an old lockset with a new one of the same type, sometimes you may want to replace an old mortise lockset on an interior or exterior door with a newer cylindrical lockset, or even replace an old cylindrical one with a newer model that is not the same size.

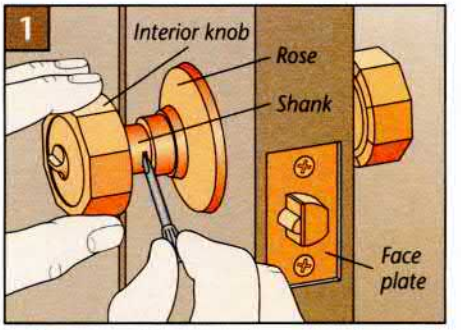
Such a change is a project requiring some skill in working with wood. Sometimes, it's simply a matter of enlarging existing holes. In other cases, you may need to patch any holes in the face of the door and refinish the door. Then you'll have to measure and cut new holes to fit the new lockset. Where security is a major concern, it is sometimes safer to replace the entire door.

If you're replacing a mortise lockset with a cylindrical or tubular one, you'll need to fill in the mortise as well as patch the door face, then refinish the door and cut a hole for the cylinder. There are kits that convert a mortise lockset to a cylindrical or tubular one.

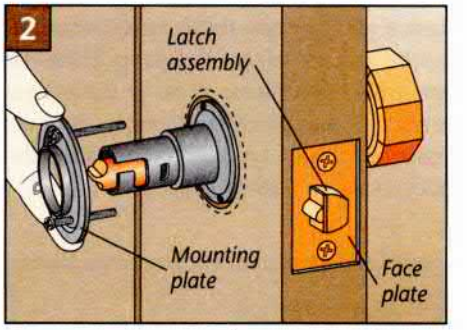
Parts of a cylindrical lockset



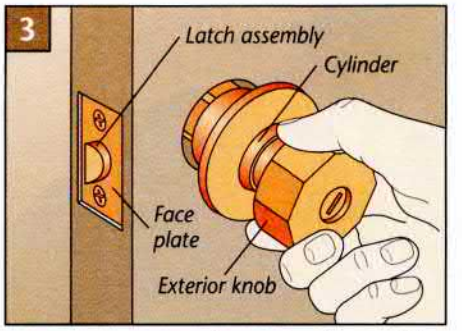
Replacing a cylindrical lockset



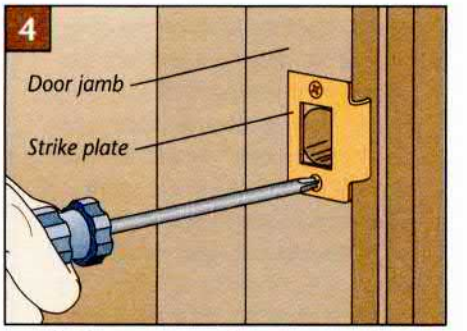
Push a screwdriver into the slot on the shank (or insert a nail into the hole) or push the shank button to release the interior knob. Snap off the rose.



Unscrew and remove the mounting plate; snap out the exterior knob and cylinder. Unscrew and remove the face plate, latch assembly, and strike plate.



Insert and screw on the new latch assembly and face plate. Holding the exterior knob and cylinder, slide the cylinder in and engage it with the latch assembly.



Attach the mounting plate; snap on the interior rose and knob. Screw on the new strike plate and check that the latch engages in the strike plate.

...DOOR LOCKSETS

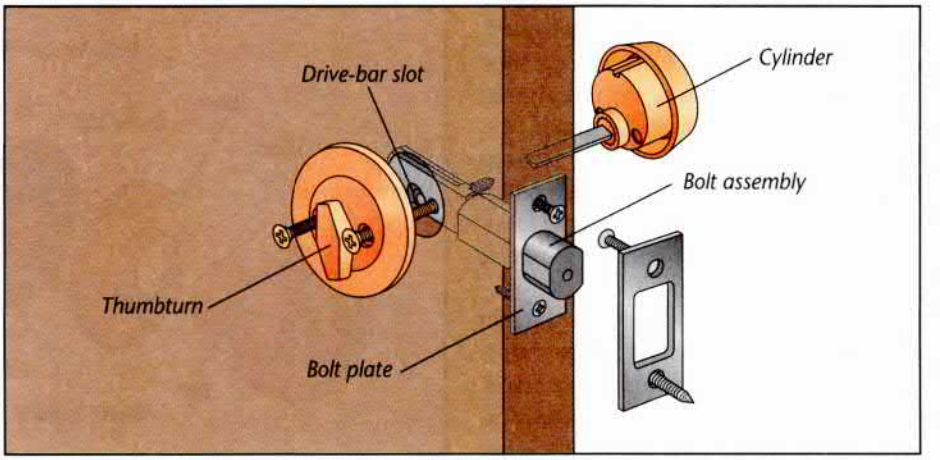
Deadbolt Locksets

Deadbolt locksets are commonly used on exterior doors. These single-cylinder deadbolts are usually opened from the exterior with a key and on the inside by hand. Double-cylinder deadbolts, from the same family, are opened by a key on either side. While these are the most secure on doors with windows, they may be prohibited by local building and fire codes, so check the regulations in your state before installing this type.

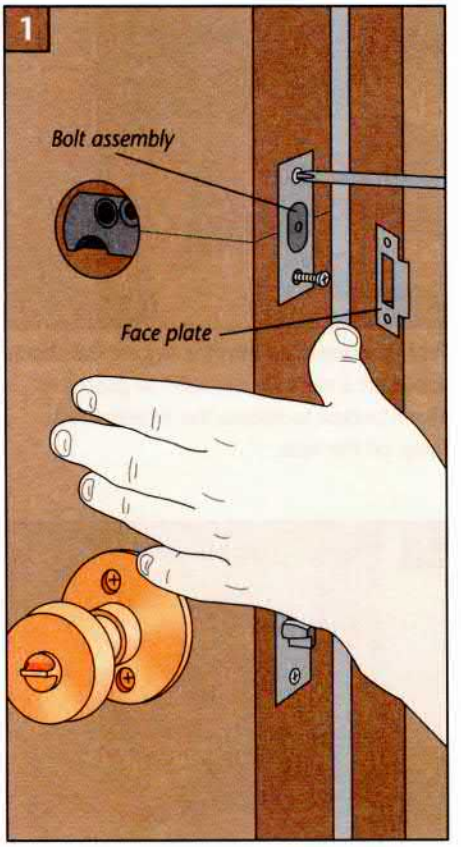
A deadbolt lockset provides an added level of security so long as it is in good shape. For minor lockset problems, such as a sticky latch, refer to the troubleshooting guide on page 74. However, for anything other than minor problems, it is often best to simply replace the lock as shown at right.

Replacing a deadbolt lockset is a simple task if you buy one the same as or similar to the lockset you are replacing. These are available at hardware stores or sometimes from the manufacturer directly. All necessary hardware typically comes with the lockset when you buy it.

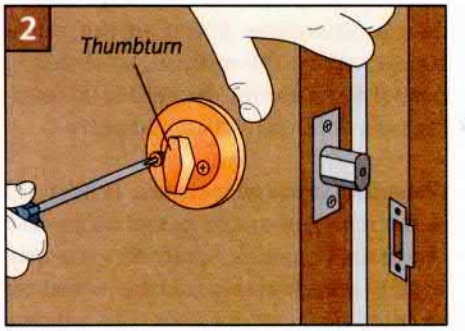
Parts of a deadbolt lockset



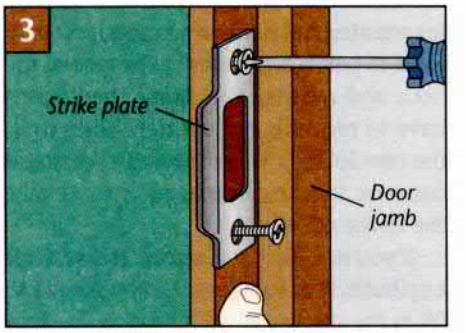
Replacing a deadbolt lockset



Remove the old lock. Measure the thickness and perimeter of the face plate and, if necessary, drill and chisel larger holes. Insert the bolt assembly and screw on the bolt plate.



Mount the cylinder assembly, carefully and precisely inserting the drive bar into the drive-bar slot. Screw the face plate into place on the door's exterior.



Use 3-inch screws to install the reinforcing plate and the strike plate. You may have to chisel the door jamb so the plates sit flush with the door-jamb edge.

QUICK FIX-UP

TIGHTENING A LOOSE DOORKNOB

Often, the doorknobs of old-fashioned mortise locksets become loose over time. To tighten them, loosen the screw on the knob's shank. Hold the knob on the other side of the door tight and turn the loose one clockwise until it fits snugly against the rose. Then tighten the screw until you feel it resting against the flat side of the spindle. The knob should then turn freely.

If this doesn't help, remove the knob and check the spindle; if it's worn, it must be replaced. If the whole lockset is worn, it is best to replace it entirely.

Rim Locksets

Rim locks are secure locks that can be used as either the only lockset on an exterior door or in conjunction with other locks for added security. The rim lock has a bolt that fits through the strike plate on the door jamb and is controlled by either a key on the outside or a thumbturn on the inside of the door.

When a rim lockset fails, refer to the troubleshooting chart on page 74. If repairs are impossible, you can replace it easily, as shown at right.

All you need to replace your rim lockset is a lock of the same size and type as the one you are replacing and a screwdriver. The hardware should be supplied by the manufacturer and the holes for the lock should match those already in the door. You may have to shorten the drive bar of the cylinder, depending on the thickness of your door, by snapping it at one of the perforated grooves with a pair of pliers.

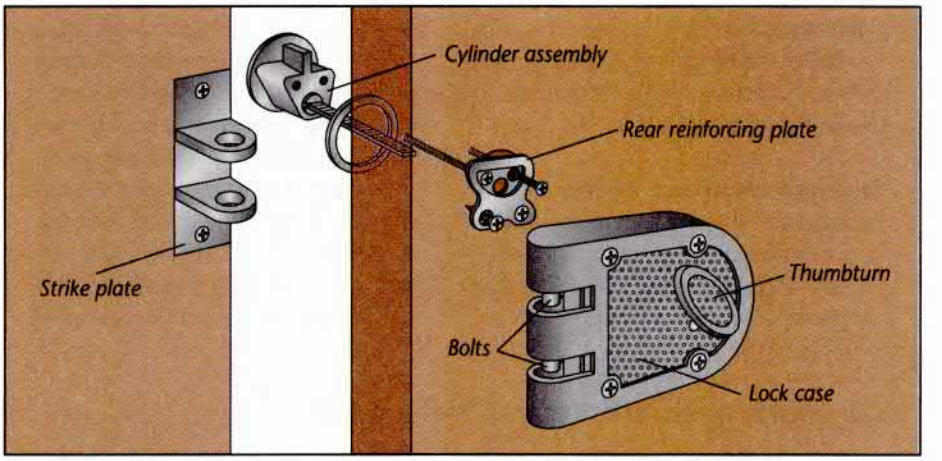
Should you buy a different type of rim lockset, you may have to change the size and depth of the mortise for the strike plate and alter the circumference of the hole in the door to accommodate the new cylinder assembly.

PROFESSIONAL TIPS

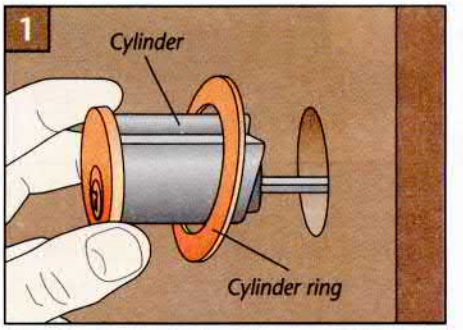
INSTALLING LOCKS IN NEW DOORS

Lock manufacturers will provide all the hardware for locksets, but if new holes have to be bored to accommodate a new lock you will have to do the job yourself. But if you order a prehung door and know the measurements of the lock you will be installing, you can give the template and specifications to the door manufacturer. They will bore the necessary holes for the door and jamb. This will make installing your lock much easier.

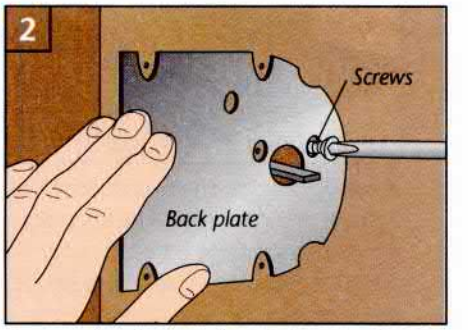
Parts of a rim lockset



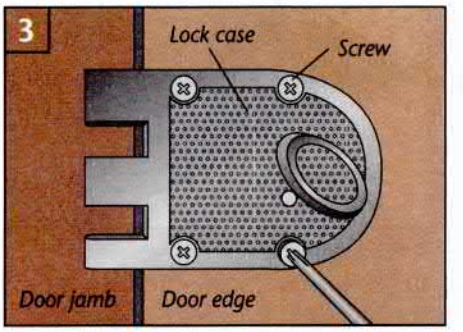
Replacing a rim lock



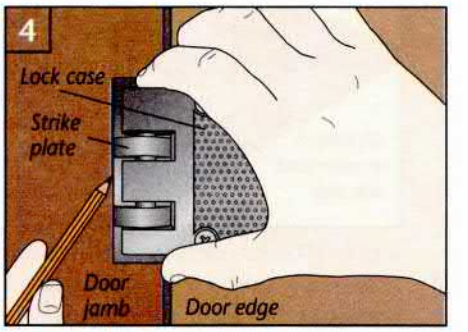
Slide ring over cylinder, then insert the cylinder and drive bar into hole so the keyhole is on the outside and the bar is in the horizontal position.



Place the back plate 1/8 inch from the door edge on the inside. Drive screws through the plate into the screw holes in the cylinder.



Place bolt in the unlocked position. Fit the drive bar into the slot on the rear side of the lock case and attach it to the inside of the door using the screws provided.



Hold the strike plate in position and measure and mark it when the bolt is in the locked position. Cut a mortise, if necessary, and screw the strike plate in place.

Weatherstripping Doors

Drafts and moisture can penetrate easily through the cracks around an unsealed door. You can shut them out by applying weatherstripping to the door bottom and jambs. On these pages are a few of the types available.

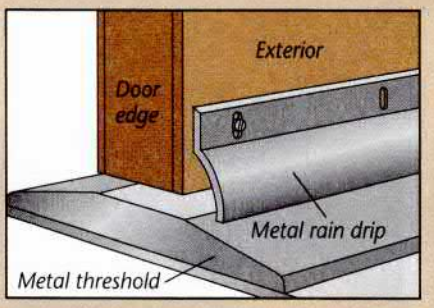
Before installing weatherstripping, be sure to correct any fit problems on the door itself *(pages 66-67)*.

Types of weatherstripping. For sealing the bottom of a door, you can use a rain drip, door sweep, automatic sweep, or door shoe *(see below)*. Rain drips merely shed rain; other types block both drafts and moisture. Also available are special thresholds that act as weatherstripping. Each comes in standard door widths but can usually be trimmed to fit.

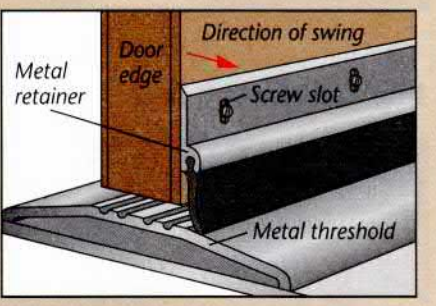
For weatherstripping a door jamb, select spring-metal or cushion-vinyl, foam, gasket, or interlocking weatherstripping *(see facing page)*. The spring-metal and cushion-vinyl types provide an efficient seal and are unobtrusive, but they tend to make a door difficult to open and close. Foam weatherstripping can be peeled off and replaced. Gasket weatherstripping (either pliable or rigid) is an efficient method, though very visible. Interlocking weatherstripping for both door bottoms and jambs can be either surface-mounted or recessed in the door. Both installations require precise fitting. The recessed type (not shown here) fits into grooves in the door and frame; unless you're skilled, let a professional install it.

Adjusting weatherstripping. If your weatherstripping is ineffective, try these remedies. Bend spring-metal or cushion-vinyl weatherstripping to increase the pressure on the door. If threshold weatherstripping has elongated screw holes, adjust the height for a better fit.

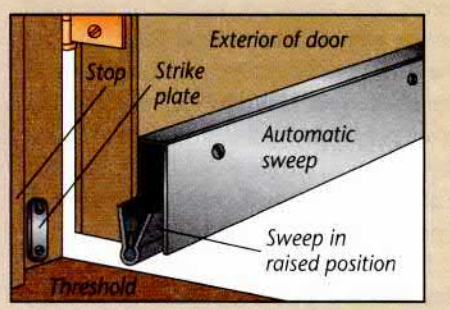
Six kinds of threshold weatherstripping



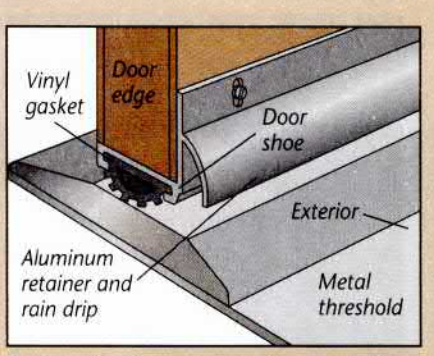
A metal rain drip sheds rain from the bottom of a door; you'll need additional weatherstripping with this type. To install the rain drip, cut it to size and screw it onto the lower outside edge of the door.



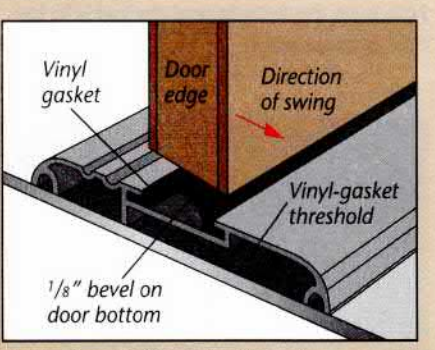
A door sweep screws onto the door's bottom face; elongated screw slots allow for height adjustment. Place the sweep on exterior side of an outward-swinging door, interior side of an inward-swinging one.



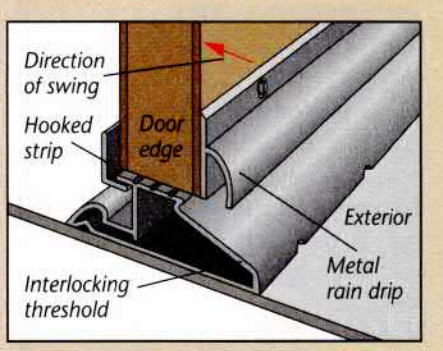
An automatic sweep has a sweep spring-loaded inside a metal frame. The sweep retracts to clear the floor when the door is opened. (When trimming the sweep to fit, take care not to cut the springs.)



A door shoe has an aluminum retainer holding a rounded vinyl gasket that presses lightly against the threshold when the door is closed. Notch the rain drip at both ends to clear stops.

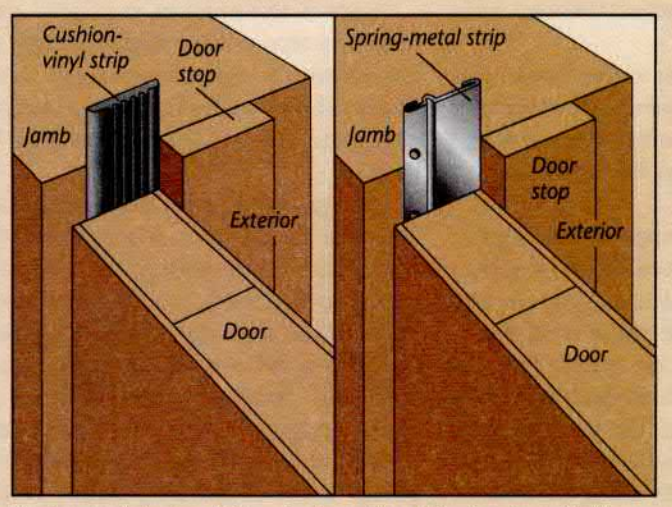


A vinyl-gasket threshold replaces a standard one. The door should press lightly against the gasket when closed. Bevel the door bottom 1/8 inch, tapering down in the direction of the swing.

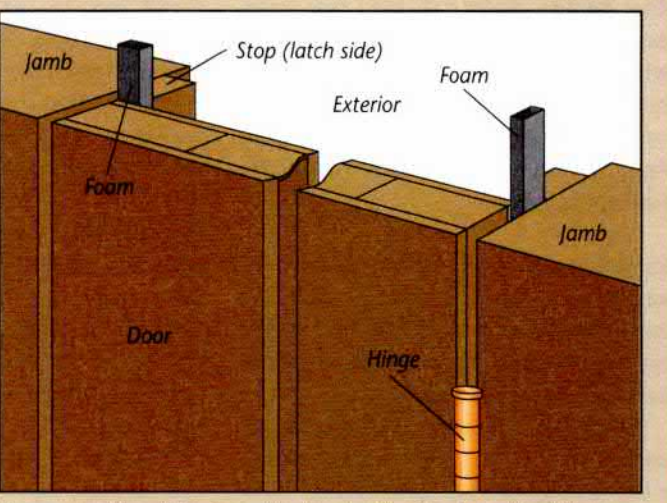


A surface-mounted interlocking threshold consists of a threshold plus a hooked strip that's mounted on the door. Allow a 1/8-inch clearance between the threshold and the door bottom.

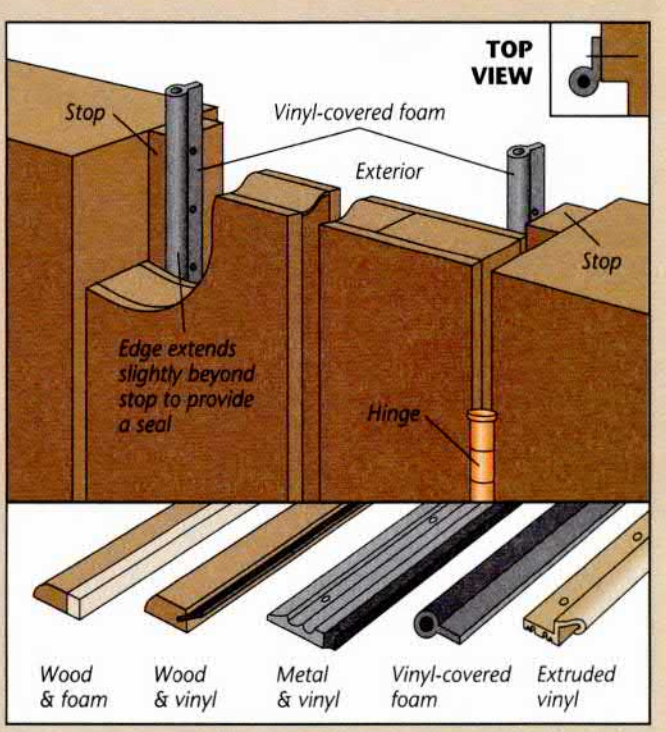
Four types of jamb weatherstripping



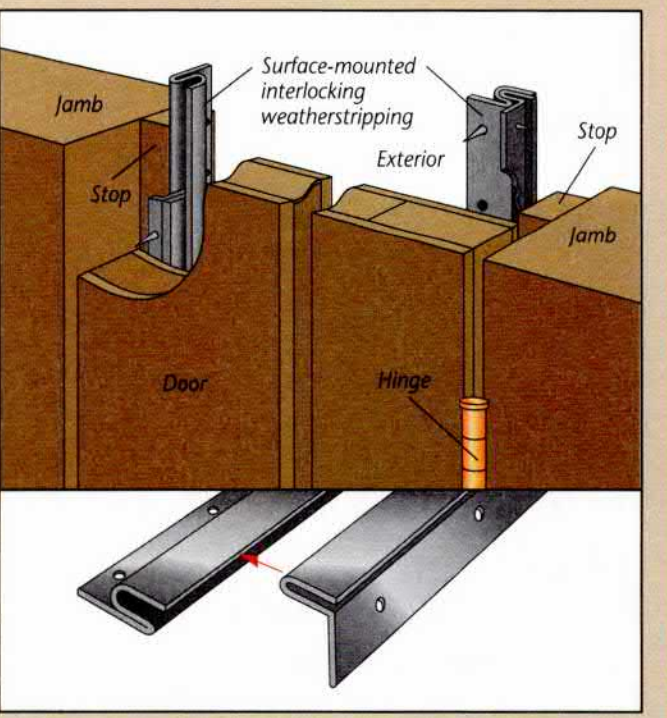
Spring-metal or cushion-vinyl weatherstripping is nailed to jambs around the door, starting on the hinge side. Strips butt against the stops; miter the top corners and cut the lock-side strip to fit around the strike plate.



Foam weatherstripping attaches to the jamb on the hinge side and to the stops on the latch side and top. Adhesive-backed types are pressed into place; others are nailed with either rust-resistant carpet tacks or small nails.



Gasket weatherstripping is nailed or screwed to the face of the stops and head jamb. Attach the top piece so it's flush with the side stops; the side pieces should butt against the top piece (you may need to notch the top end of the side strips so they fit tightly). The seal should be light. Be careful not to kink the strips as you attach them.



Surface-mounted interlocking weatherstripping is nailed to both the door and the stops (follow the manufacturer's directions). Fit the top strips first, then attach the side strips to the jambs and the door edges, using small nails. Precise fitting is essential—the channels must align exactly in order for weatherstripping to be effective.

GARAGE DOORS

Most garage doors fall into two categories—roll-up, or sectional, doors and swing-up, or one-piece, doors. Both get their lifting power from coiled metal counterbalance springs and require only minimal human or motorized effort for their operation.

Repairing a garage door. A garage door may bind or drag because of poor roller and track alignment. If the door won't stay up or down, an adjustment of the tension may be necessary.

CAUTION: Adjusting or replacing the tension spring on a roll-up garage door or the springs of a swing-up garage door is a dangerous job best left to a professional, but you can adjust the wire cable *(see facing page)*.

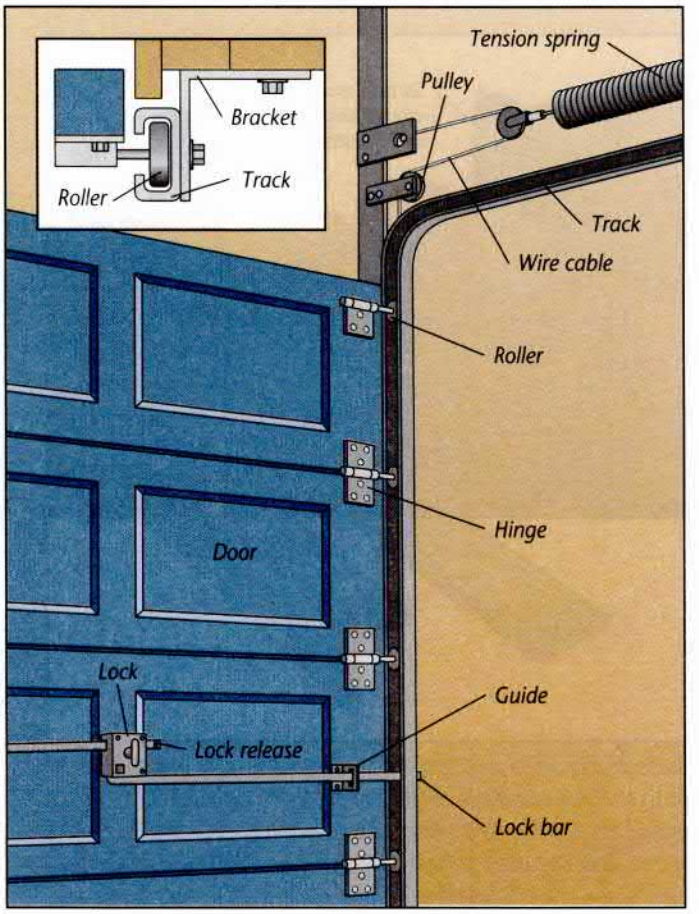
A one-piece door is susceptible to sagging if it's left in the open position for long periods of time. To minimize the warp, see "Quick Fix-up" on the facing page.

Maintaining a garage door. Regular maintenance will head off most garage door problems. Periodically clean the tracks and lubricate them with penetrating oil or silicone spray. Tighten screws on hardware, and clean and lubricate hinges and rollers. Use graphite spray on the lock. Keep the door itself sealed and painted, especially along the bottom edge, to prevent moisture damage.

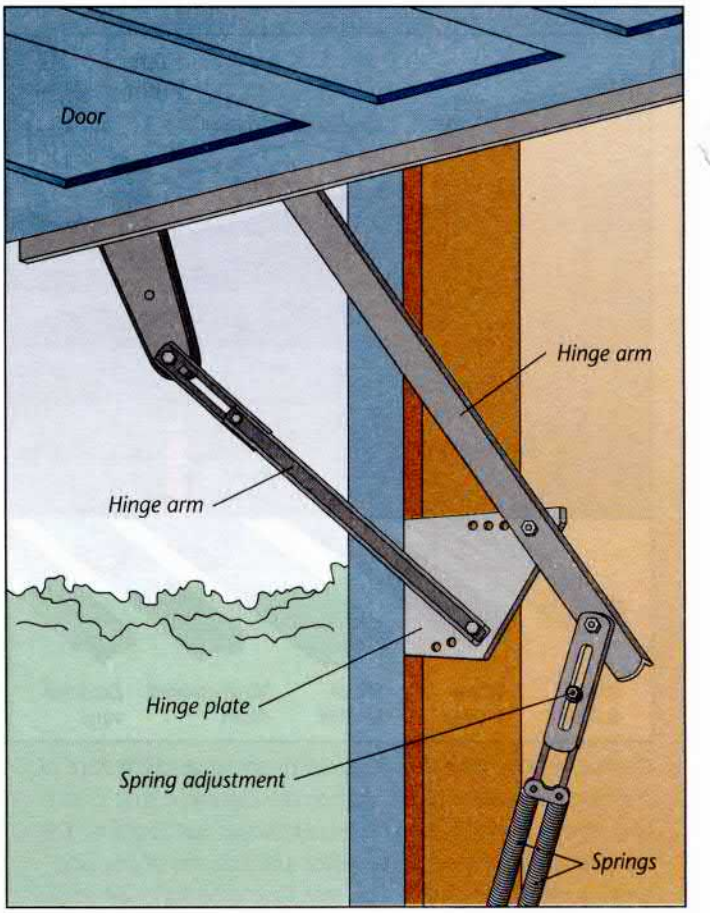
Inspect the springs regularly and have any that are developing bulges or are unevenly spaced replaced. Have safety cables installed in the springs for one-piece doors if they're not already in place.

Garage doors, especially those that enclose a heated space, should be weatherstripped. Weatherstripping is usually nailed to the outside of a roll-up door on both the sides and the bottom, and to the face of the overhead jamb. On a swing-up door, only the bottom is weatherstripped. You may be able to find sweeps and shoes made specially for garage doors at building supply stores or garage door companies.

Two types of overhead garage doors



A roll-up door has either two tension springs, one at each side of the door, as shown above, or a single spring that extends across the top of the garage door opening.



A swing-up door, also called a one-piece door, pivots on hinges and usually has springs on each side to adjust the balance (only one side is shown in this drawing).

Automatic Door Openers

Automatic door openers can be used with all types of overhead doors, provided the unit selected is suited to the particular door.

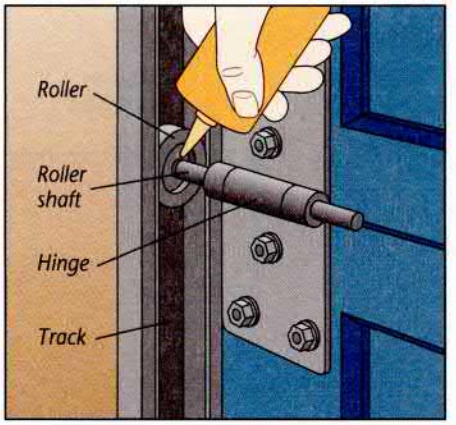
If you're having problems with a door that has an automatic opener, disconnect it and try the door manually; this will tell you if the opener or the mechanics of the door are in need of repair. The door should work effortlessly before it is connected to the motorized opener. Do not compensate for a bad door by adjusting the door opener; this will just wear out the opener.

An opener must have an automatic reverse switch or "electronic eye" so that it reverses automatically when an obstacle is in the way. Test this function regularly by placing a 1 1/2-inch object under the door opening when the door is open. If the door hits the object, turn the adjustment knob according to the directions in your manual.

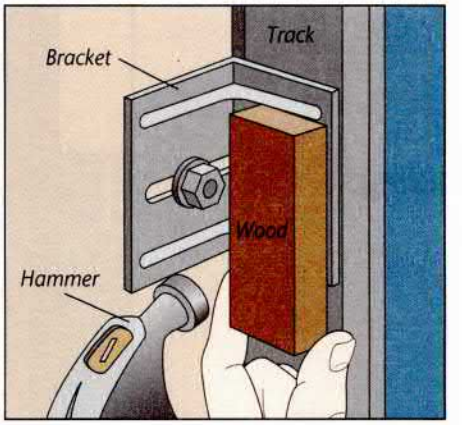
If the door doesn't open or close completely, tighten the height adjustment nuts located inside the housing, testing the door until it operates correctly.

Since each door opener operates differently, refer to the owner's manual when making any repairs.

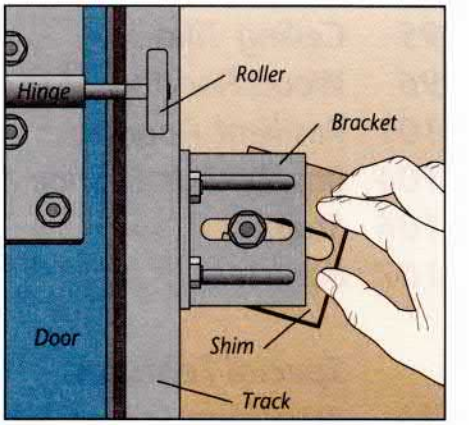
Five garage door repairs



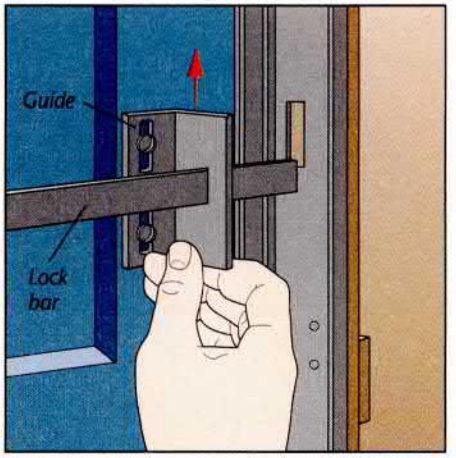
If the rollers bind, the cause may be bent or loose hinges. Tighten loose hinges and repair bent ones. Replace broken rollers and lubricate them with penetrating oil.



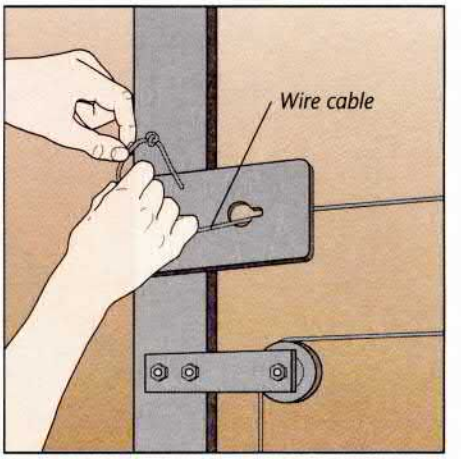
If the door drags, the tracks may be out of alignment. Loosen the brackets and tap the track with a hammer or mallet and a wood block until it's aligned; tighten the brackets.



If the door binds due to rollers improperly positioned or set too deep, adjust the placement of the brackets. In some cases, the brackets may need to be shimmed out.



If the lock bar doesn't catch, loosen the screws in the guide and move it up or down until the lock bar does catch. Then, tighten the screws.



Adjust the tension on a roll-up door by pulling on the wire cable to take up slack (door should be in open position). Knot the end of the cable to secure it in the slot.

QUICK FIX-UP

SAGGING GARAGE DOORS

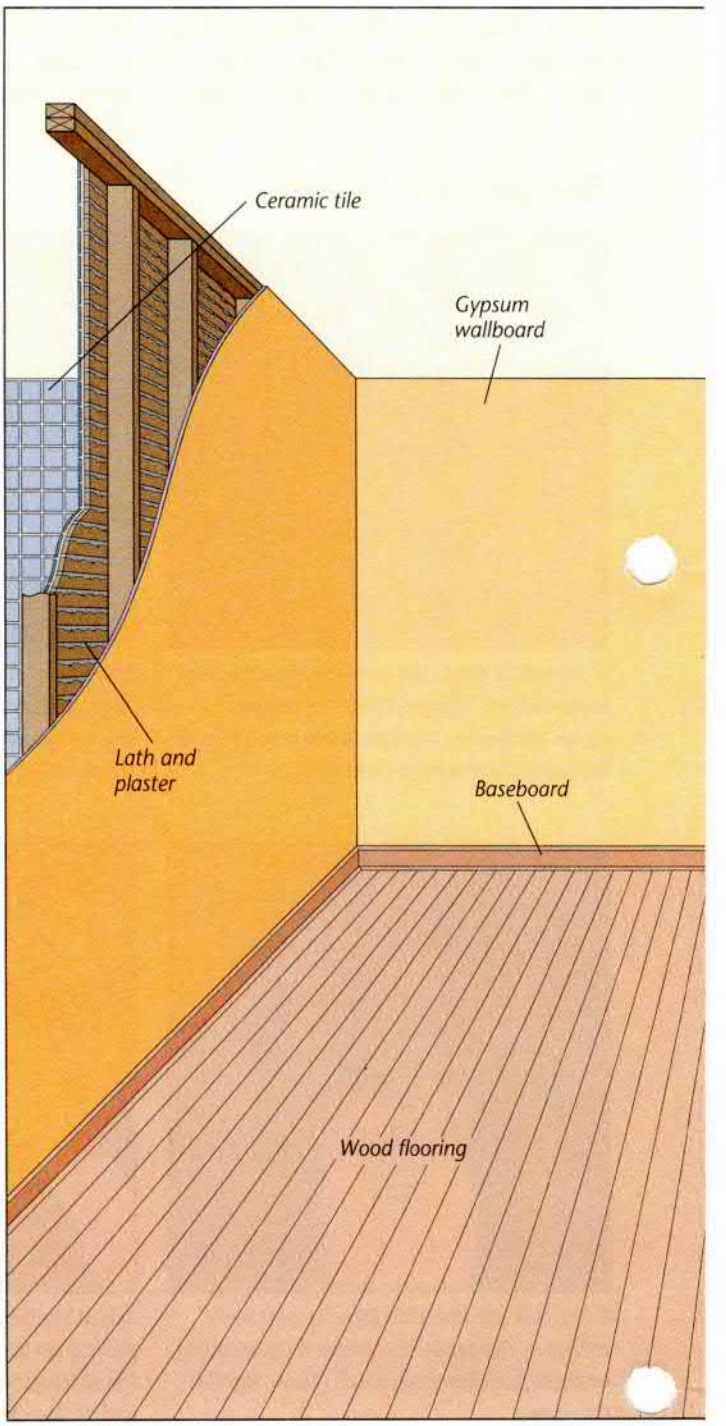
If a swing-up, or one-piece, garage door sags in the middle, attach metal reinforcing rods or metal strips along the top and bottom of the door, using spacers between the rods and the door at the midpoint of each rod. Adjust the spacers and rods so that the door has a 1/2-inch outward warp, eliminating any sagging. The rods can be adjusted simply by turning the nuts located at each end of them.

Walls, Floors, & Stairs

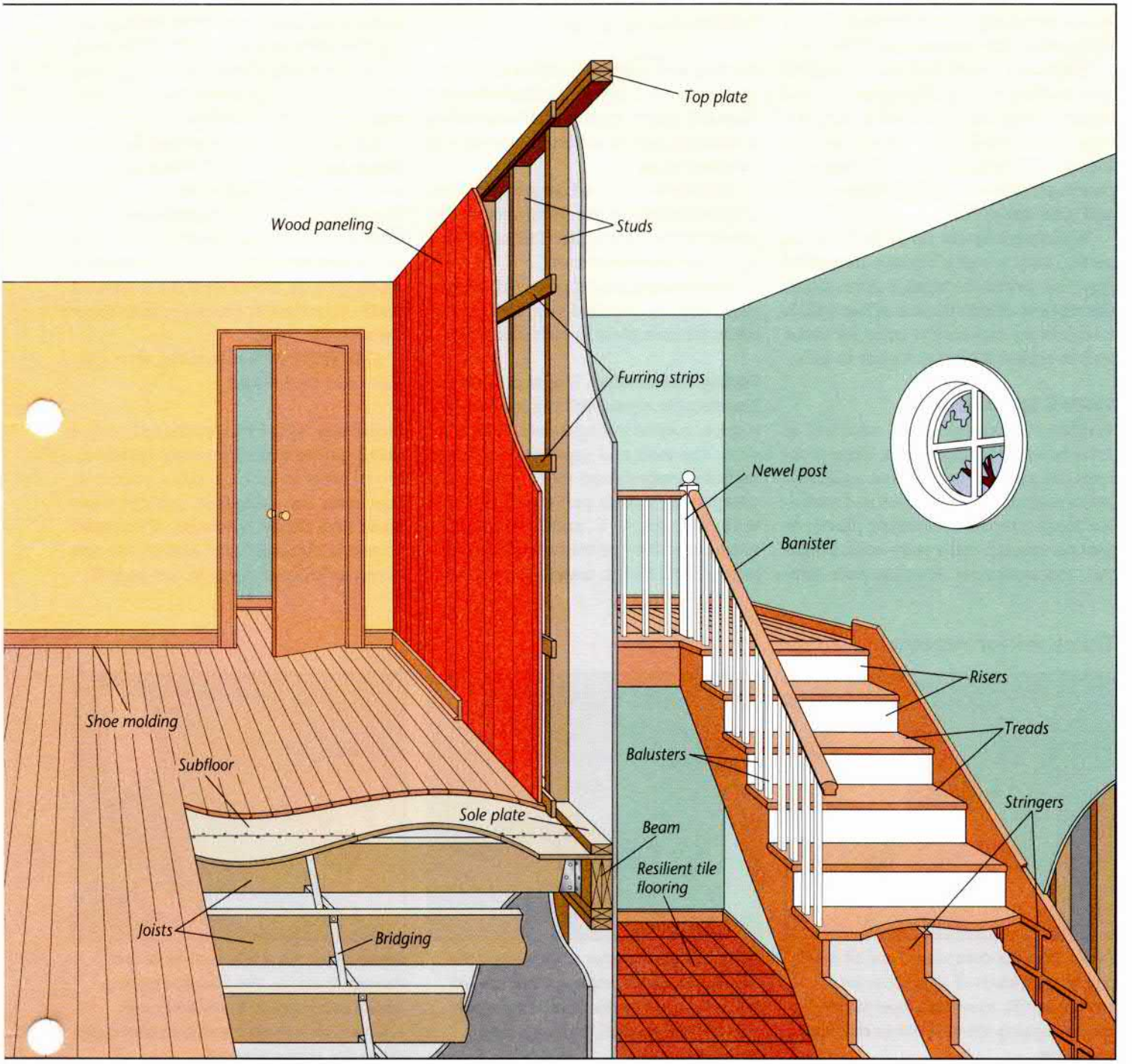
84 *Gypsum Wallboard*
88 *Plastered Walls*
90 *Paneled Walls*
92 *Tiled Walls*
94 *Wallpaper*
95 *Ceiling Tiles*
96 *Wood Flooring*
101 *Resilient Flooring*
104 *Baseboards & Shoe Moldings*
106 *Stairs*
107 *Banisters*

Special Features

93 *Attaching Special Wall Fasteners*
95 *Painting Over Wall Repairs*
103 *Removing Stains from Resilient Flooring*



Revealed below are structures usually hidden from view inside walls and under floors and stairs. You'll notice, too, a variety of popular surface materials—tile, gypsum wallboard, and wood paneling, as well as wood and resilient flooring. In this chapter, you'll learn how to repair them all, in addition to remedies for such hazards as a loose banister or floor board.



GYPSUM WALLBOARD

Gypsum wallboard is used as a backing for many wall treatments—wallpaper, fabric, tile, and even paneling. It is also the most common painted surface. Standard wallboard is composed of a fire-resistant gypsum core sandwiched between two layers of paper. Some wallboard is water resistant for use in damp areas. Though panels are usually 4- by 8-feet and 1/2-inch thick, other sizes are also available.

Wallboard panels may be fastened to wall studs or furring strips *(page 83)* and attached with wallboard nails, annular-ring nails, wallboard screws, and/or adhesive. Usually, the joints between the panels are covered with wallboard tape and joint compound.

Wallboard repairs range from fixing minor dents to replacing an entire panel *(page 86)*. When the work is done, finish the repair to match the rest of the wall. It is sometimes necessary to paint the entire wall to ensure the repair blends in fully.

MAKING MINOR REPAIRS

Wallboard ills include dents, small nail or screw holes, and popped nails. These problems can usually be repaired as shown below with simple techniques and tools—spackling compound, patching plaster, or joint compound, and a putty knife, a hammer, and sandpaper. After you have completed fixing the damage, you'll need to sand and prime the area, and finish it to match the rest of the wall.

REPAIRING A LARGE HOLE

To repair a large hole, the damaged section of wallboard must be cut out and replaced with a new piece of the same thickness *(see facing page)*.

Cutting and nailing. To remove the damaged wallboard, first locate the wall studs *(page 87)*. Use a keyhole saw and utility knife to cut out the section, centering side cuts over studs.

CAUTION: To avoid danger from electrical wires behind the walls, shut off the power to the circuit *(page 152)* and run a light from another circuit.

Cut the replacement piece and smooth edges with a perforated rasp; then nail or screw the new piece in place *(page 87)*.

Taping and sanding. This step, the key to blending the repair with the surrounding surface, is done in stages over a period of days. The tools and supplies you'll need include ready-mixed all-purpose joint compound; 2-inch perforated or mesh wallboard tape; 4-, 6-, and 10-inch taping knives; and 400-grit silicon-carbide sandpaper. NOTE: With water-resistant wallboard, use water-resistant joint compound (following package directions).

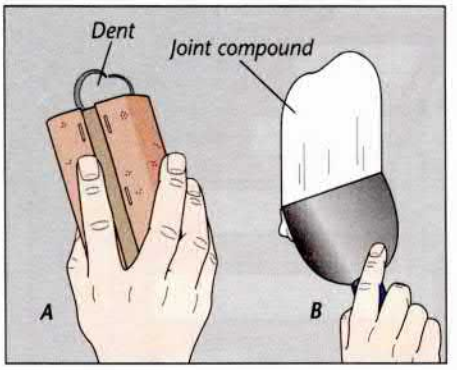
Apply tape and layers of joint compound following the steps on the facing page *(see page 87 for finishing corners)*. To apply compound, dip the edge of a clean taping-knife blade into the compound, loading about half the blade. Apply the compound across the joint; then, holding the knife at a 45° angle to the wall, draw the blade along the joint. Using increasingly wider knives for each layer makes the joint smoother.

Let each layer dry for at least 24 hours before applying the next. When dry, wet-sand the compound to remove minor imperfections by wetting the compound with a sponge and sanding along the joints with sandpaper wrapped around a sanding block. Never sand the wallboard itself—scratches in the paper may show through the finish.

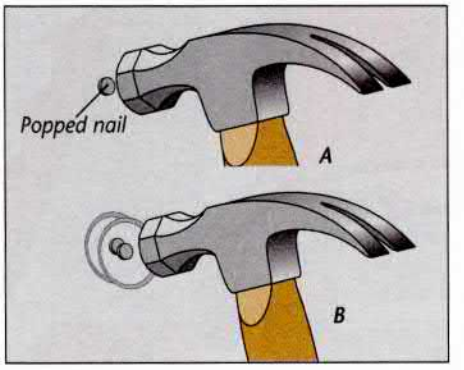
CAUTION: When sanding, wear goggles and a dust mask.

Finishing. Wipe the wallboard with a damp sponge to remove sanding residue. If you want to paint, apply a primer or base coat. For wallpaper, seal the wallboard with shellac or varnish. If you need to match a textured wall surface, use one of the techniques described on page 88.

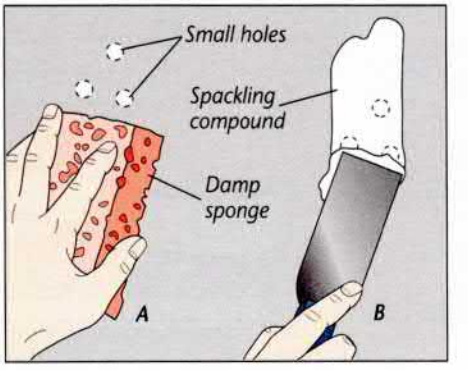
Three minor repairs



Dent. Sand the dent site (A) and fill it with one or more layers of all-purpose joint compound (B); allow each layer to dry before applying the next. When dry, sand and prime.

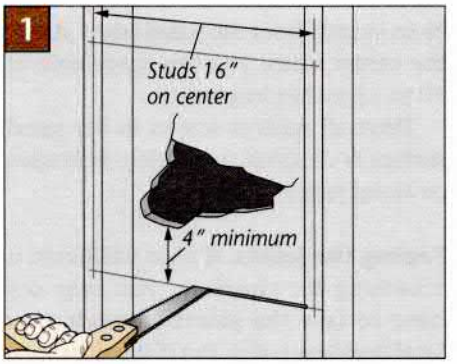


Popped nail. Hammer in and dimple the nail (A); drive and dimple another nail just beside to hold it in (B). Cover the dimples with joint compound. When dry, sand and prime.

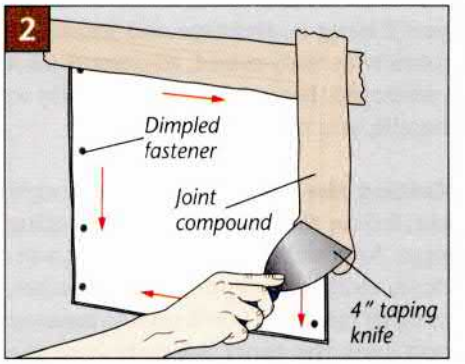


Small holes. Brush the holes clean and dampen them (A). Use a flexible, narrow-bladed putty knife to fill the holes with spackling compound or patching plaster (B). When dry, sand and prime.

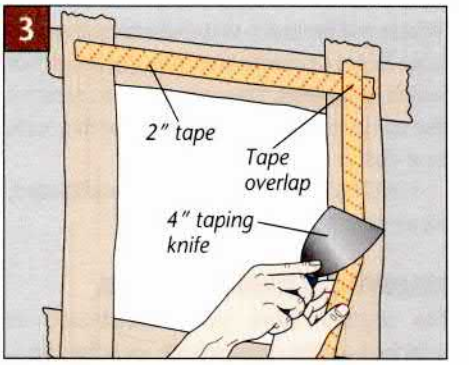
Repairing a hole in wallboard



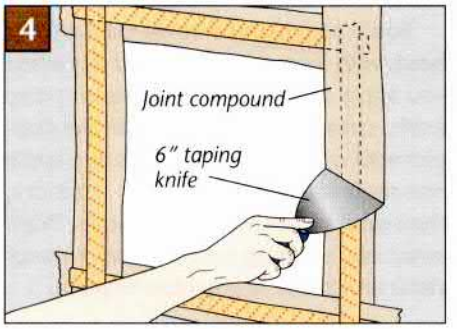
With a keyhole saw, cut the damaged wallboard between the studs; cut the sides and corners with a utility knife. Remove the piece with a prybar; pull out remaining nails.



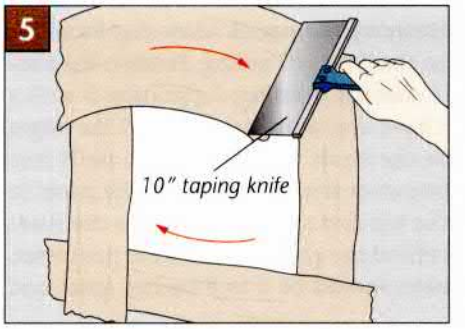
Nail or screw a new piece of wallboard into place *(see page 87)*. Apply a large daub of joint compound across a joint with a 4-inch taping knife and draw the knife along the joints at a 45° angle to the wall.



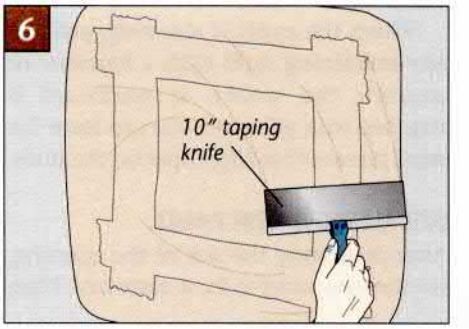
Center tape over each joint; press down. Remove excess compound with a knife, feathering the edges. Thinly apply compound over the tape. When dry, wet-sand the compound *(see facing page)*.



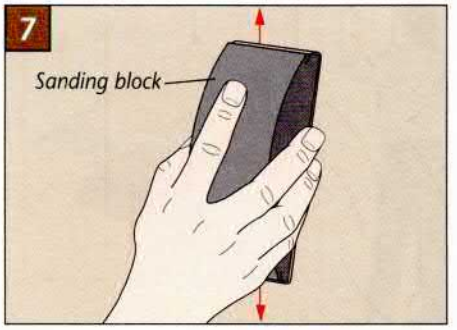
Apply a second coat of compound, using a 6-inch taping knife; feather the edges. When the compound is dry, wet-sand the edges to remove minor imperfections.



Apply a third coat of compound, using a 10-inch taping knife held at a 45° angle to the wall. (Use only as much compound as necessary to cover the previous layer.)



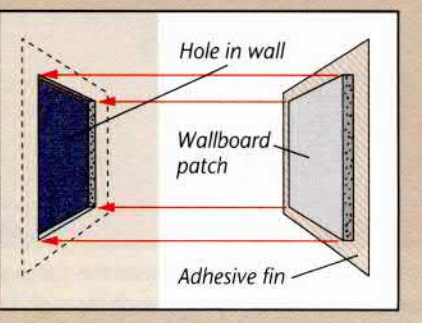
Feather the edges of the third coat 12 to 18 inches out, using a 10-inch taping knife. Try to remove any ridges in the compound. Allow the compound to dry before doing the final sanding.



With a sponge and sanding block, wet-sand to remove imperfections. Wipe off sanding residue and prime or paint. For wallpaper, seal with shellac or varnish. For a textured wall, see page 88.

Wallboard Patches with Adhesive Fins

Many building supply stores sell precut wallboard patches that are held in place with adhesive fins. Available in a range of sizes, they provide a convenient alternative to traditional wallboard patches. For a proper fit, the hole sometimes has to be widened to accommodate the patch. After the fins are smoothed onto the wall, the patch is covered with joint compound and finished.



Replacing a Wallboard Panel

When wallboard is water-damaged or has large holes or cracks that run the length or width of a panel, you may need to remove the entire panel and replace it with a new one cut to size.

CAUTION: When sanding wallboard, wear goggles and a dust mask.

REMOVING A DAMAGED PANEL

No matter how your wallboard is attached—with nails, screws, or adhesive—the removal procedure is exactly the same.

Use a utility knife to slit through the taped joints. Then punch through the center of the panel with a hammer or prybar and pull off pieces. Working from the center, use a broad-bladed prybar to pry the panel off the studs.

When the panel is removed, pull out any remaining nails with a hammer or unscrew the screws. If wallboard is attached with adhesive, you can leave the small pieces of backing paper on the studs.

INSTALLING A NEW PANEL

After measuring the size of the opening, cut the new panel to fit, if necessary. Then you'll hang it, and tape and finish the joints with ready-mixed, all-purpose joint compound. Because wallboard is bulky to handle, you may need a helper.

Cutting the panel. To make a straight cut, follow the directions on the facing page. To fit wallboard around doors, windows, electrical receptacles and switches, or other openings, you'll need to measure and mark the panel. Measure from the vertical edges of the opening to the edge of the nearest panel or to a corner; measure from the horizontal edges to the ceiling. Transfer your measurements to the wallboard and cut the panel, using a keyhole saw.

Hanging the panel. Mark stud locations on the floor and ceiling. Position the panel over the opening, supporting it with a 1-by-4 and a prybar, and nail the edges to the studs with wallboard nails (see below) or screws. Also fasten the panel to the top and sole plates, and to the studs behind the panel. Around the perimeter, nails should be 6 to 8 inches apart and 3/8 to 1/2 inch from the panel edges. Along the center studs, you can space nails at 10 to 12 inches intervals.

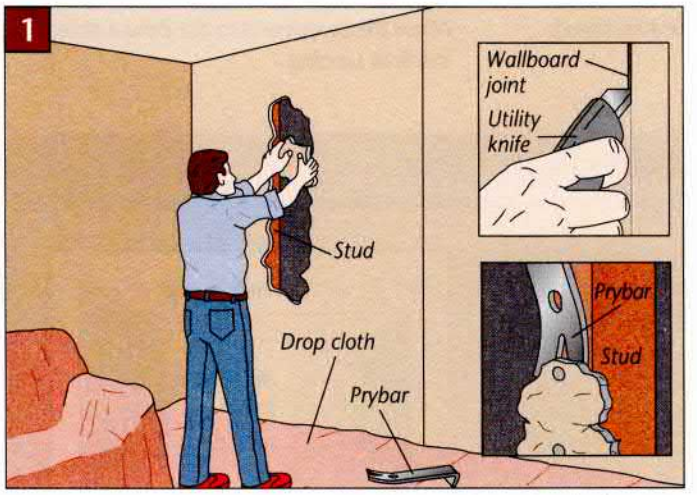
Drive all nails or screws so the panel surface is dimpled *(see nailing techniques on facing page)*.

Taping the joints. If your wallboard is a backing for paneling, you may not have to tape the joints (consult your local building code). But if it will be covered with paint, wallpaper, a textured finish, or tile, you'll have to tape all joints and cover all nail or screw heads with joint compound.

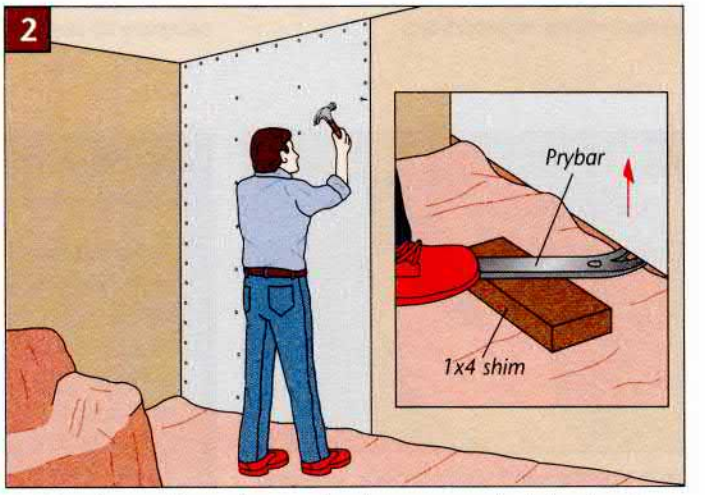
Follow Steps 2 to 7 on page 85 to tape the joints and apply compound. To tape corners, see the facing page.

You'll also have to cover the fastener heads with joint compound. Do this when you apply the tape. Using a 4-inch putty knife, cover the heads and fill the dimples with compound. When it's dry, apply one more coat over the heads. Let it dry, then sand as you would the joints. Wipe away any sanding residue with a damp cloth and prime if you plan to paint.

Hanging a replacement panel



Slit through taped joints between the damaged panel and adjacent panels, using a utility knife. Punch through the center with a hammer or prybar and pull off pieces. Working from the center, pry the panel edges off the studs with a prybar.



Position the panel over the opening (you may need a helper) and support it as shown in the inset. Nail into each stud near the top of the panel first to hold it; then finish nailing, spacing nails 6 to 8 inches at the perimeter, 10 to 12 inches in the center.

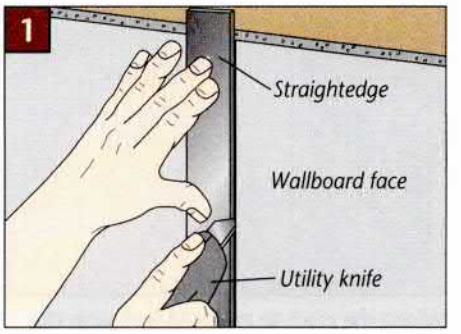
Techniques for Working with Wallboard

Working with wallboard involves using special techniques when you're cutting it, nailing it, or working with corners.

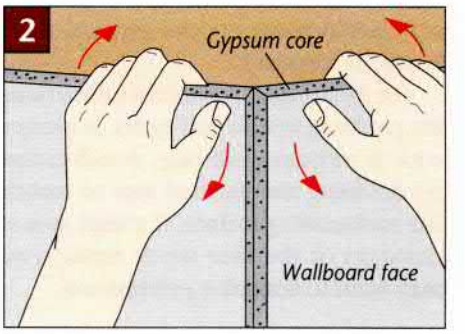
When cutting wallboard, get a helper to hold the panel while you mark, score, and break it. When you nail wallboard, it's important to dimple the surface without puncturing the face paper or crushing the core. It takes practice—the secret is to hammer the nail heads squarely.

To tape corners, you'll need a corner tool and precreased tape for the inside corners, metal corner bead for the outside corners. As with other joints, you feather the compound edges with 6- and 10-inch taping knives.

Cutting wallboard



While a helper supports the panel, mark the cutting line on the panel's face, using a pencil and straightedge; with a utility knife and straightedge, deeply score the panel face.



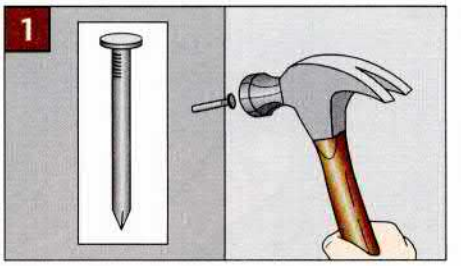
Break the gypsum core by snapping the shorter section away from you. Tilt the short section back slightly while your helper cuts the back paper with a utility knife.

PROFESSIONAL TIPS

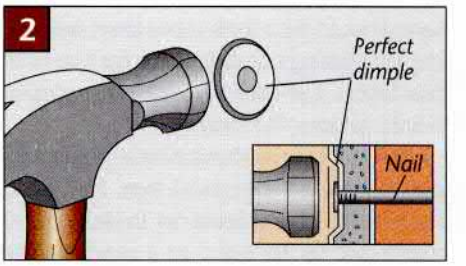
LOCATING STUDS

If you can't locate a stud in your wall using an electronic stud finder, try probing into the wall in an inconspicuous place about 2 inches above the floor with a nail or drill. When you find a stud, measure 16 or 24 inches from that point to find the center of the next stud. Then patch the holes *(page 84)*.

Nailing wallboard

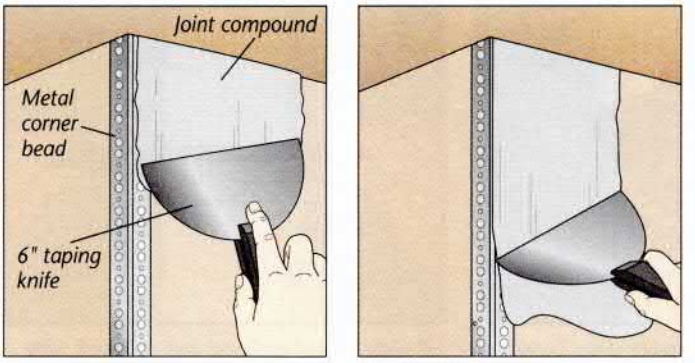


Drive wallboard nails through the wallboard into studs. Space the nails 8 inches apart 3/8 to 1/2 inch from the edges of the panels and 10 to 12 inches along the center studs.

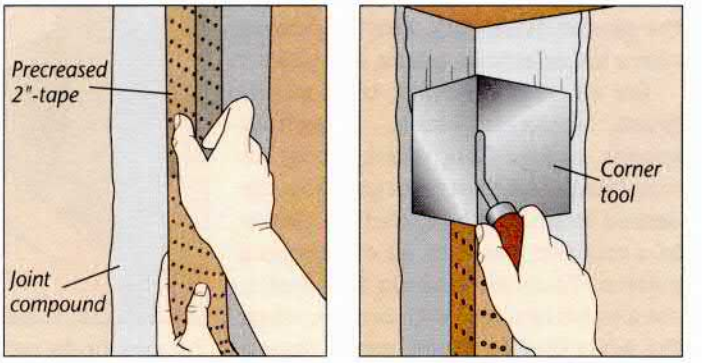


Drive nails in squarely until the heads are flush. Dimple the wallboard with another blow; don't puncture the surface or crush the core.

Taping wallboard corners



On an outside corner, nail up the metal corner bead. Using a 6-inch taping knife, apply joint compound across one side and smooth it vertically; repeat on the other side.



On an inside comer, apply a layer of joint compound with a 6-inch taping knife and cover with tape. Using a corner tool, press the tape into the compound and add a thin layer of compound over the tape.

PLASTERED WALLS

Plastered walls are composed of three layers: a base coat, a thick coat of plaster for strength, and a finishing coat for appearance. These may be applied over wood lath, metal mesh, special gypsum wallboard, or masonry.

On these pages, you'll find instructions for patching cracks and holes in plaster with or without a lath base, as well as tips on finishing the patched area to match the surrounding surface. If a large area is damaged or the base needs repair, you may want to consult a professional.

Patching cracks and holes. Fine cracks, nail holes, and small gouges in plaster usually can be repaired with spackling compound. You can also fill cracks with a special crack patcher.

To patch wide cracks and holes, apply two layers of patching plaster plus a layer of fine-textured finishing plaster. The first layer should fill a little more than half the depth, leaving enough space for the next two layers. Let each layer dry completely before adding the next.

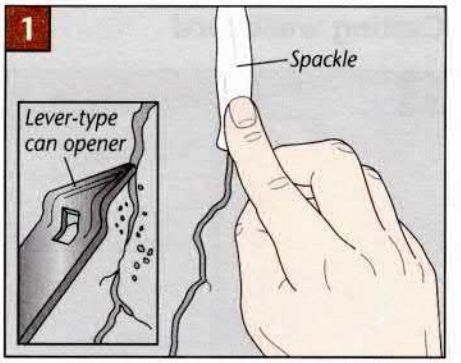
To fill a hole without a base (for example, where an electrical box has been removed), you'll have to install metal mesh *(see facing page)* or a ready-made patch *(see page 85)*.

Finishing the patch. Matching an existing texture requires skillful treatment of the still-wet finishing plaster. You'll have to experiment to achieve a good match.

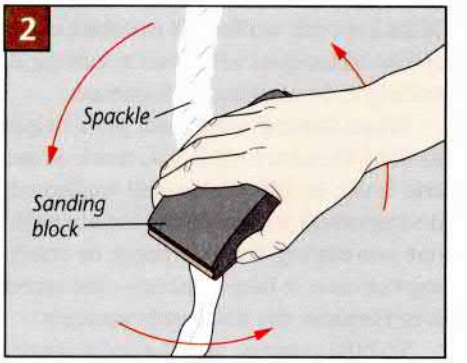
For a smooth surface, pull a metal float or wide putty knife dipped in water across the plaster. When dry, sand to remove minor imperfections, prime, and paint.

For a textured surface, use a paintbrush, stippling brush, household sponge, sponge float, whisk broom, or wire brush—whatever will give you the desired finish. Daub or swirl the plaster in a uniform, random, or overlapping pattern. To create peaks in the plaster, use a brush or a tool with bristles; when the peaks start to stiffen, gently draw a clean metal float over the surface to smooth them. Let the plaster dry; then prime and paint.

Patching fine cracks

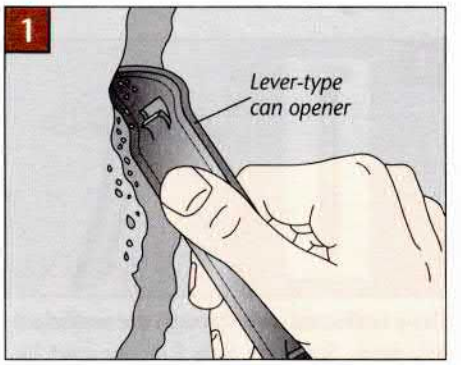


Widen the crack to about 1/8 inch with the tip of a lever-type can opener; blow out dust and debris. With your finger or a putty knife, fill the crack with spackle.

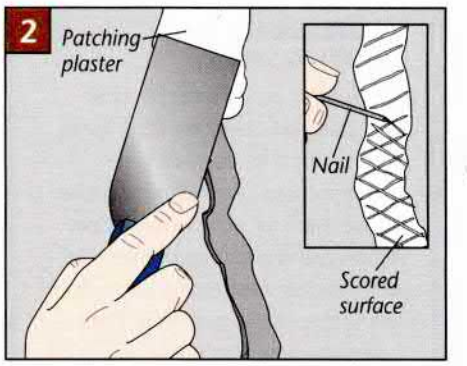


Sand the spackle when dry, using a block wrapped with fine-grade sandpaper; sand in a circular motion. Prime the patch with sealer before painting.

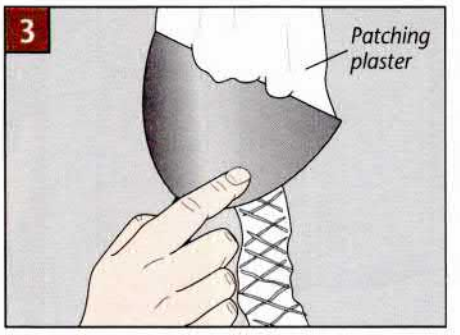
Patching wide cracks



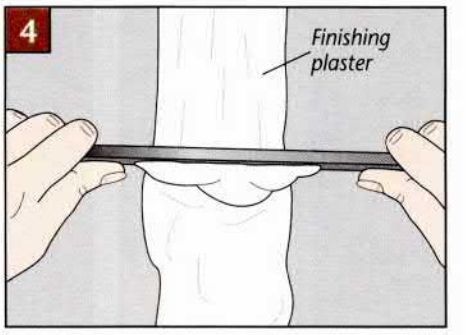
Undercut the crack with a lever-type can opener or a putty knife to help bond the new plaster; blow out dust and debris. Dampen the crack with a sponge.



Use a putty knife to fill just over half the depth of the crack with patching plaster. Score the plaster with a nail when firm but not hard to provide "bite" for the next layer.



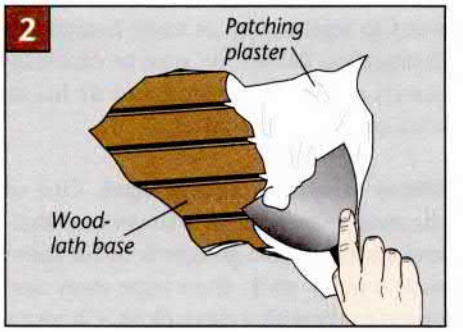
Dampen the dry patch again; use a broad knife to apply the next layer to within 1/8 to 1/4 inch of the surface. Let the patch dry before applying the finish coat.



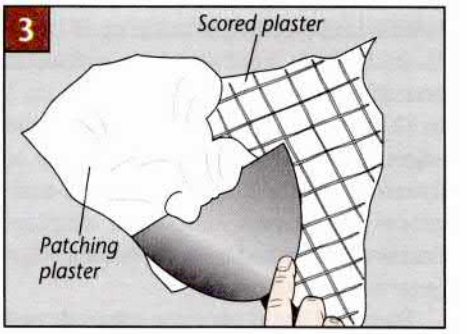
Fill with finishing plaster and strike off with a straightedge to remove excess. To finish, see "Finishing the patch" at left. When dry, prime and paint.

Patching a hole with a base

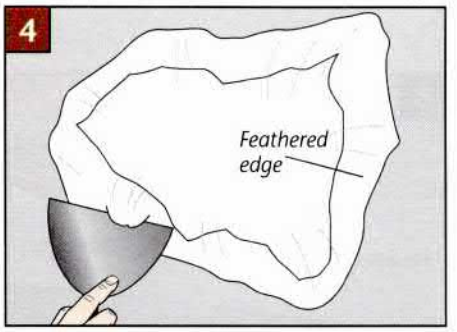
Remove cracked plaster from the edges of the hole with a cold chisel and hammer. Undercut the edges to ensure a good bond; blow away debris. Dampen the edges with a sponge.



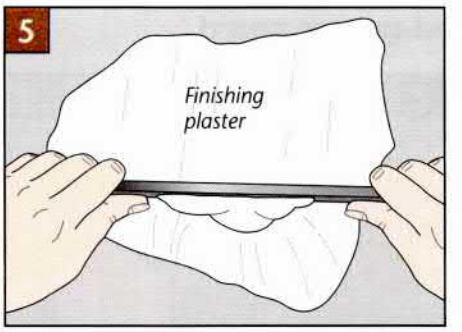
Using a broad knife, fill a little more than half the hole's depth with patching plaster; force it through gaps in the lath. Score the plaster with a nail when firm and let dry.



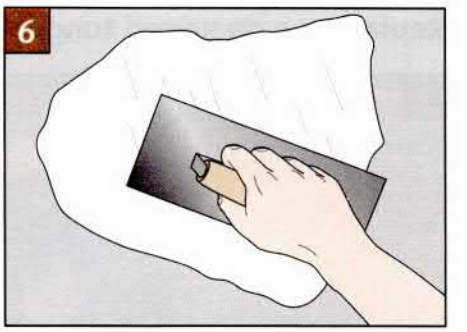
Dampen the patch again; use a broad knife to apply a second layer of plaster to within 1/8 to 1/4 inch of the surface. Score the plaster with a nail to provide "bite" for the next layer; let the plaster dry.



Use a broad knife (for a large hole, a 10-inch taping knife) to apply finishing plaster; feather the edges an inch or more beyond the edges of the patch.

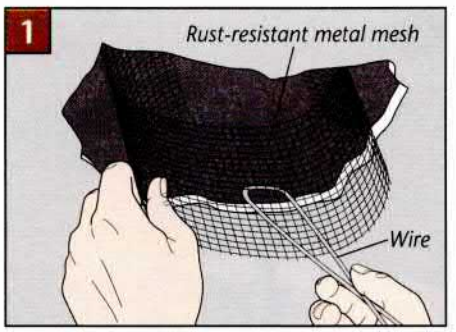


Strike off the wet finishing plaster with a straightedge to remove excess plaster. For a textured surface, see "Finishing the patch" on the facing page.

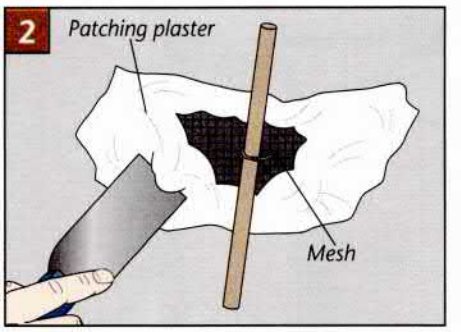


For a smooth finish, dip a metal float in water and, holding the float at a slight angle to the wall, draw it down from top to bottom. When dry, sand and prime.

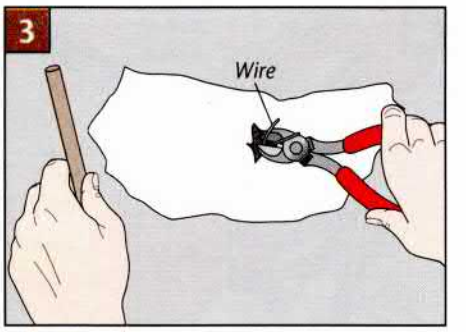
Patching a hole without a base



After removing loose plaster from around the hole with a cold chisel and hammer, loop a wire through a piece of rust-resistant metal mesh. Roll the edges, insert into the hole, and flatten mesh by pulling wire.



Tightly wind the wire around a stick. Dampen the hole's edges with a sponge. Using a putty knife, fill just over half the hole's depth with patching plaster, forcing it through the mesh.



Unwind the wire; remove it and the stick. When the plaster is firm, score it with a nail to provide "bite" for the next layer. Finish the patch as shown in Steps 4-6 above.

Repairing Solid-board Paneling

Solid-board paneling is made up of 1/4- to 3/4-inch-thick hardwood or softwood boards or plywood strips ranging from 3 to 12 inches wide. Boards may have square edges, but most are milled to overlap or interlock. Milling may be tongue-and-groove, as shown below, or shiplap. Paneling is attached to studs, furring strips *(page 83)*, or wallboard.

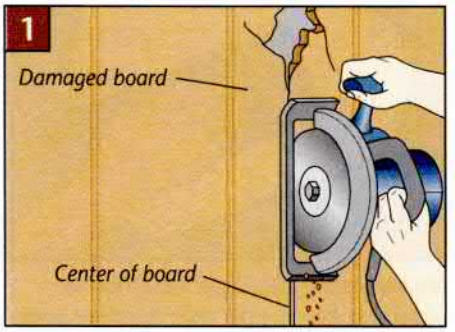
Damaged board paneling responds well to a variety of techniques for repairing minor scratches and gouges, dents, and even deep gouges. But if you can't repair the damaged paneling to your satisfaction or if the damage is more serious, you may want to replace one or more boards *(see instructions below)*. Be sure to carefully match any new paneling and its finish with adjacent surfaces.

Minor scratches and gouges. One of the most common ways to conceal shallow scratches and gouges is to fill them with a putty stick, then wipe away any excess putty with a clean cloth. Choose a color that matches the finish of your paneling. You can also conceal minor scratches on paneling as for furniture—with furniture polish or an almond stick, a compressed fabric stick impregnated with oil.

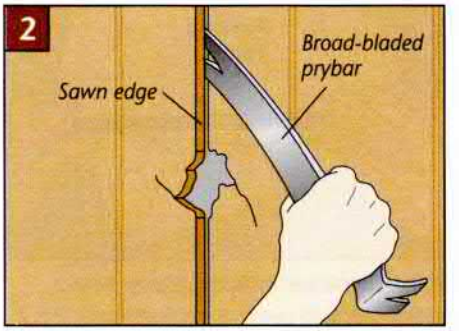
Dents and deep gouges. You can try to restore dented wood fibers by removing all the finish from the dent site, then placing a damp cloth and hot iron over the dent until the wood fibers rise to the level of the surrounding surface. Let the wood dry thoroughly before sanding it smooth and refinishing the area to match.

To repair a deep gouge or a nail hole, fill it with a matching wood putty, using a flexible putty knife to apply the putty. Let it dry; then sand the patch smooth with fine-grade sandpaper wrapped around a sanding block. Finish it to match the surrounding area.

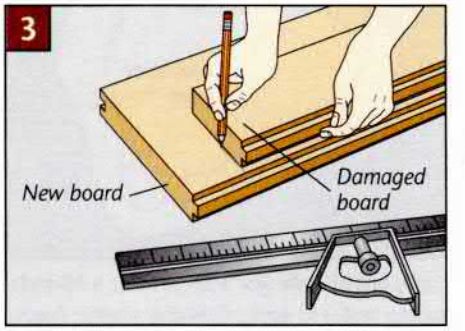
Replacing a damaged tongue-and-groove board



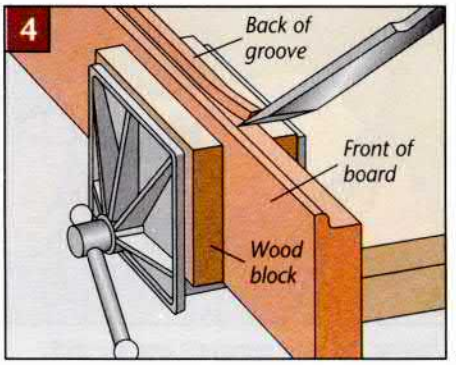
Remove the baseboard *(see Step 1, facing page)*. Adjust the blade depth of a circular saw to the board's thickness. Saw up the board's center; split the ends with a chisel.



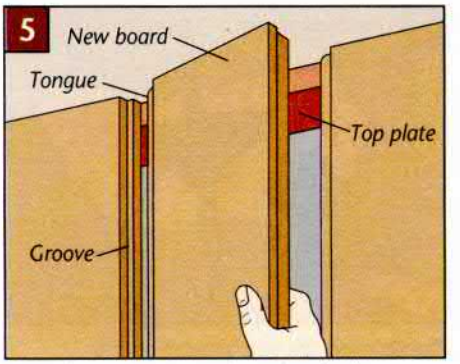
Wedge a broad-bladed prybar or wide chisel between the sawn edges. Pry the sections away from the wall, one at a time. (The tongue section may be blind-nailed.)



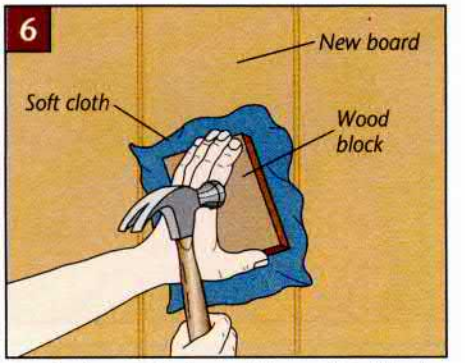
Place the damaged board over the new board; mark the correct length with a pencil and combination square. Use a crosscut saw to cut the replacement board to length.



Remove the back of the new board's groove with a wood chisel (beveled side down) and a mallet, holding the board in a vise and using wood blocks to protect the board.



Align the replacement board with the adjacent one, starting at the ceiling. Fit the tongue of the new board into the groove of the adjacent board and slip it into place.



Tap the board in place with a padded block. Drive finishing nails at top and bottom, sinking heads with a nailset; fill holes with wood putty and finish. Replace baseboard.

Repairing Wood-veneer Sheet Paneling

Sheet paneling may have a veneer of wood, simulated wood, or even fabric or vinyl. Of these, wood veneer responds best to repair, though even your most careful efforts may show.

Panels usually measure 4- by 8-feet and are fastened to either wall studs or furring strips *(see illustration on page 83)* with adhesive or color-matched nails. Following are directions for concealing minor scratches and nicks, and for filling gouges and cracks in finished wood-veneer paneling. If you can't conceal the damage to your satisfaction or if the paneling has holes, you may want to replace a panel *(see below)*.

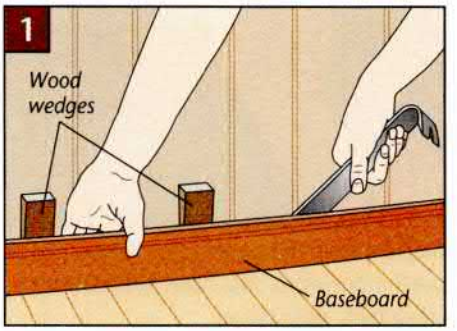
Minor scratches and nicks. The simplest way to conceal these flaws is to use a putty stick to "draw" over the mar; wipe away any excess putty with a clean cloth. (Putty sticks come in a variety of colors to match finished wood paneling.) You can also hide scratches and nicks with shoe polish (test first), floor wax, or an almond stick.

A more thorough method involves sanding, staining, and refinishing the veneer. Lightly rub the damaged area with fine steel wool or fine-grade sandpaper, applying less pressure toward the edges; wipe away any residue. Apply wood stain with a cotton swab.

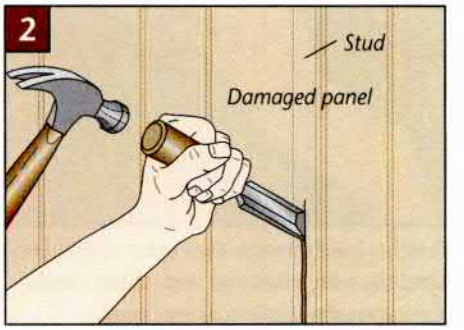
After the stain is dry, lightly buff the area again with a fine abrasive and wipe away the sanding residue. Spray a light coat of varnish on the area and let it dry; then lightly buff with a fine abrasive and wipe. If the original panels were waxed, wax the entire panel and buff to a sheen with a clean cloth.

Deep gouges and cracks. Use a putty knife to fill deep gouges and cracks with wood putty. When the putty is dry, sand it smooth. Use a small brush to stain or paint the putty so it matches the finish of the panel or use colored putty that matches the finish.

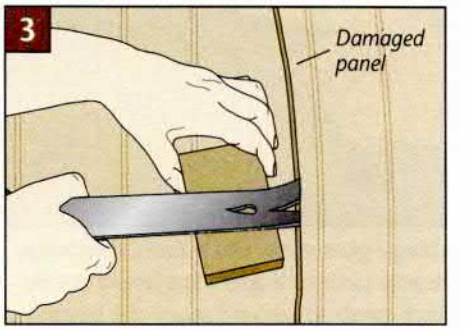
Replacing a damaged wood-veneer panel



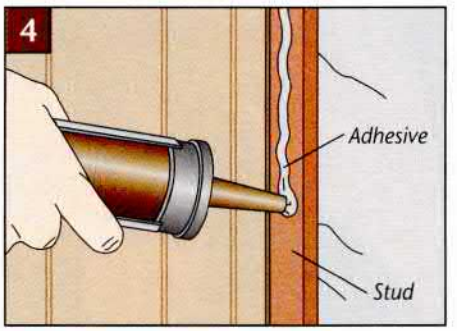
Insert a prybar between the baseboard and paneling, placing wood wedges in the gap. Pry off the baseboard and remove the remaining nails with pliers or a hammer.



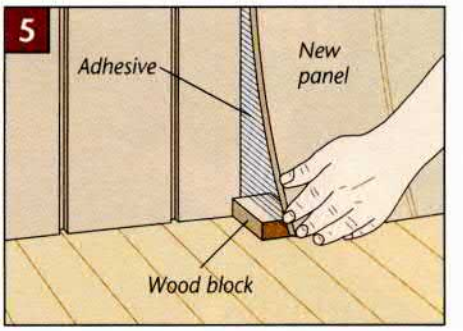
Split the panel near one edge (not on a stud), using a hammer and chisel. (The split should be large enough to allow space for inserting a prybar to pry the panel off the studs.)



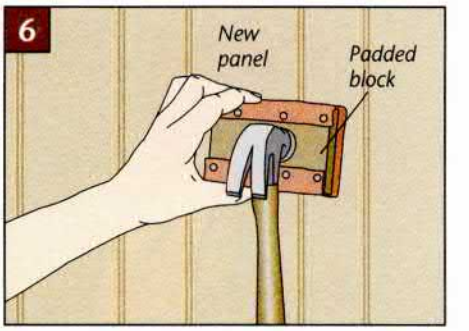
Pry the panel off the studs with a prybar, being careful not to damage adjacent panels. Wedge a prybar between the panel and studs to break any adhesive bond.



After pulling off the old paneling and scraping off any adhesive (or removing nails), apply a bead of adhesive along the length of the studs to hold the new panel.



Position the new panel; drive four finishing nails near the top of the panel to secure it. Then pull out the base, holding it with a wood block until the adhesive gets tacky.



Remove the block and press the panel in place. With a padded block, hammer along edges and over studs. Remove finishing nails if not needed. Replace baseboard.

TILED WALLS

When ceramic tiles get cracked or chipped or work loose from the wall, it's time to replace them. Before you refasten any loose tiles, check underneath—a common cause of loosening is moisture under the tiles. Be sure to correct the problem—such as a leaking pipe or roof—and check that the substructure is in good condition. Otherwise the repair will be a temporary solution at best.

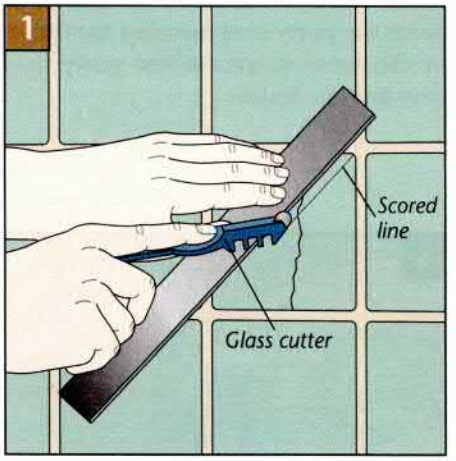
The directions below for replacing ceramic tiles apply to floors and countertops as well as walls. But note that they apply only to tiles installed in a thin-set mastic or mortar-type adhesive, not the thick mortar bed professionals use.

When you replace tiles, be sure to choose the appropriate mastic for the area you're tiling. If you're using water-resistant mastic, keep the work site well ventilated. In addition to mastic, you'll need patching plaster to create a base for the new tiles, latex primer, and grout for filling the spaces between tiles.

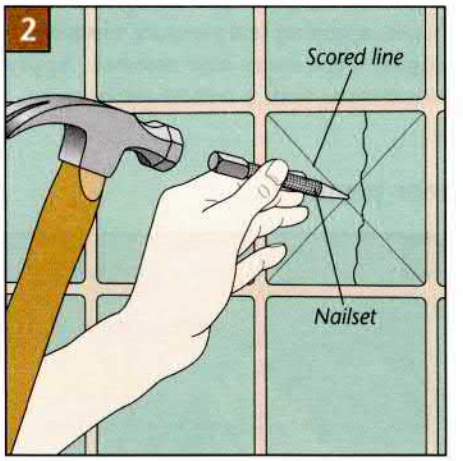
If you don't have spare tiles to replace chipped or broken ones, take a sample to a tile dealer, manufacturer, or contractor. They may have "bone piles" of old and discontinued tiles where you can find a match.

CAUTION: When chipping out old tiles, be sure to wear goggles.

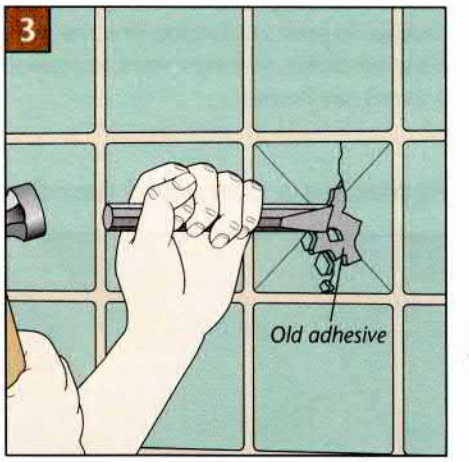
Replacing damaged ceramic tiles



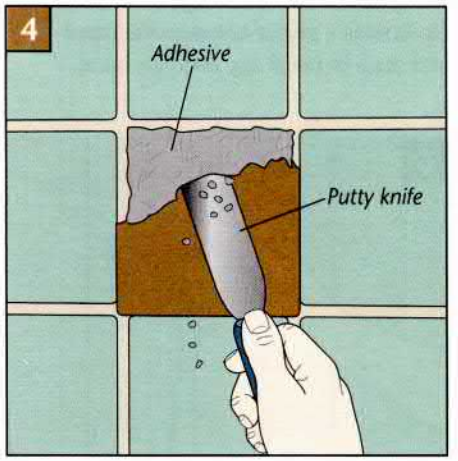
Using a glass cutter and a steel straightedge, heavily score an X across the face of the tile from corner to corner through the center.



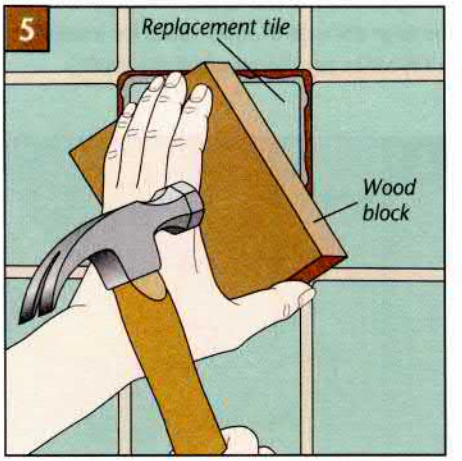
Punch a hole through the center of the damaged tile with a hammer and nailset. Avoid damaging the backing as you work.



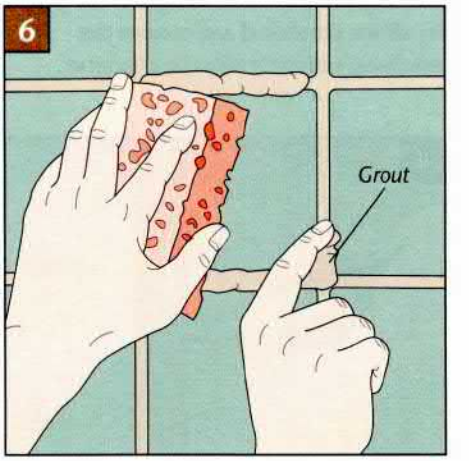
Working from the center to the edges, chip out the tile with a cold chisel and a hammer, using light, rapid blows.



Remove all old adhesive and grout behind the tile. Use sandpaper to smooth rough spots; dust. Level the backing with patching plaster, if necessary. Prime when dry.



When the primer is dry, spread mastic on the tile, keeping it within 1/2 inch from the edges. Center the tile and gently tap it flush with the surface with a wood block.



Allow 24 hours for the mastic to dry, then fill the joints with grout, using a damp sponge or cloth. Smooth the joints with a wet finger. Sponge off excess grout.

Attaching Special Wall Fasteners

Ordinary nails or screws often won't anchor firmly in plaster, gypsum wallboard, paneling, or masonry walls. To hang objects from these walls, you may need special fasteners.

Plaster, wallboard, or wood panels. You can use conventional nails to hang light objects from these walls (drill pilot holes to avoid creating cracks), though picture hooks may be a better option.

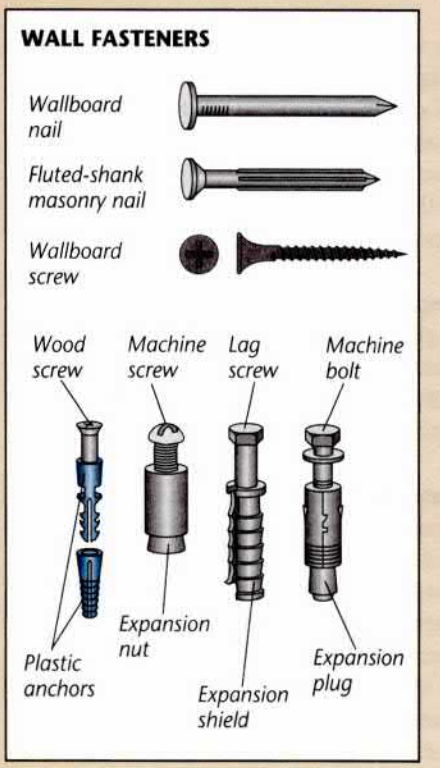
To secure shelf brackets and other heavy items, use wood screws driven into studs *(see page 87 for tips on locating studs)*. Where you can't drive into a stud, choose anchors or toggle bolts; once in the holes, they expand to distribute weight more widely than screws. Be sure to buy the proper size fastener for the thickness of the wall and the weight of the object you're hanging.

To install anchors, drill a hole, install the anchor, and insert the screw; then tighten it to spread the anchor.

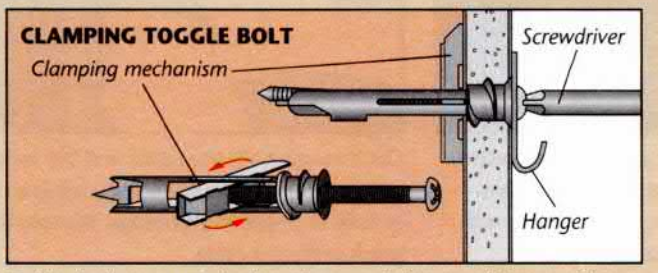
With a toggle bolt, slide the bolt through the hook or object to be mounted before inserting the toggle in a hole drilled into the wall; if you remove the bolt when the fastener is in place, you'll lose the toggle. Don't fasten the bolt or screw too tightly; this pulls the anchor or toggle into the wall material and weakens its grip.

Masonry. For these walls, hang light objects from special tempered-steel masonry nails; use anchors that have a resilient sleeve that expands to hold a screw or bolt in place for heavier objects. Drive in nails with a hammer (be sure to wear safety goggles).

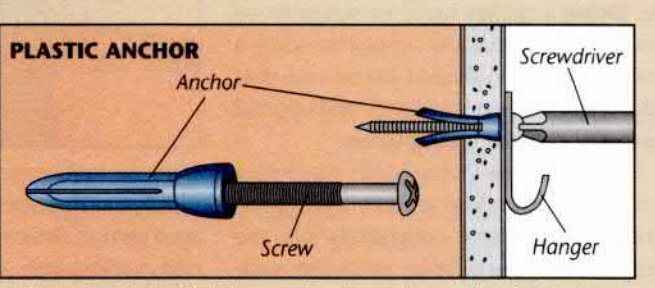
The key to successful installation of masonry anchors is proper drilling of the hole to receive the sleeve and screw. Use an electric drill with a carbide-tipped masonry bit *(page 16)* to drill the hole. Then push in the sleeve, insert the screw through whatever you are fastening, and drive it into the sleeve.



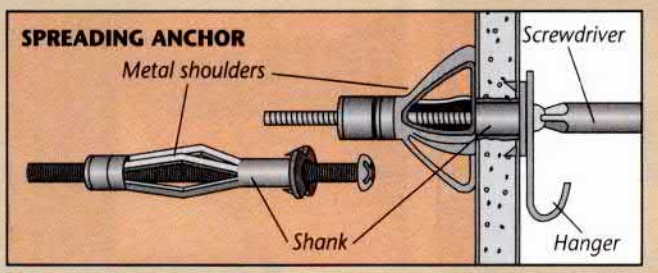
Plaster, Wallboard, & Paneling Wall Fasteners



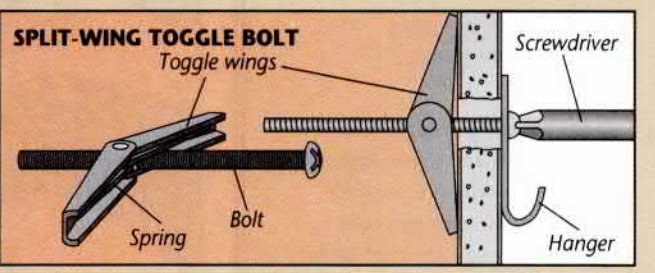
Drill a hole; press in bolt and turn with screwdriver until flush with wall and arrows on head are parallel to wall stud. Add hanger and tighten screw to engage clamp.



Drill a pilot hole slightly smaller than the anchor. Tap the anchor into the hole; add the hanger, then insert and tighten the screw.



Drill a hole; insert the anchor. Tighten the bolt until you feel resistance. Remove the bolt, add the hanger, then reinsert and tighten the bolt.



Drill a hole; insert the bolt through the hanger and toggle. Pinch the toggle wings together, insert the bolt with the toggle, and pull it toward you; tighten the bolt.

WALLPAPER

As wallpaper ages, it's subject to loosened edges, tears, bubbles, and other damage—all of which you can easily repair. When making a repair, use lap-and-seam adhesive to hold the wallpaper in place. A seam roller helps you press the wallpaper smoothly to the wall.

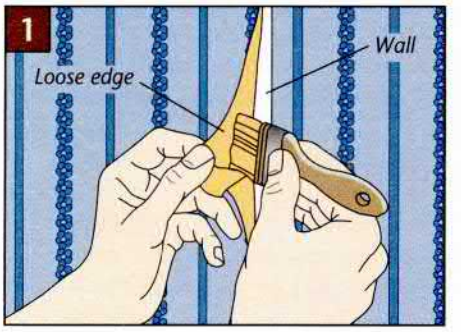
Repairing loose edges and tears. To reglue an edge or fix a tear, follow the directions at right. Don't use too much adhesive—it can soak through and create stains on the wallpaper.

Patching damaged paper. Some types of damage, such as stains, scuff marks, or wallpaper completely torn off, requires patching with a matching piece of wallpaper if one is available. Cut a square or rectangular replacement piece slightly larger than the damaged area, taking care to match patterns. Apply the patch as illustrated at right.

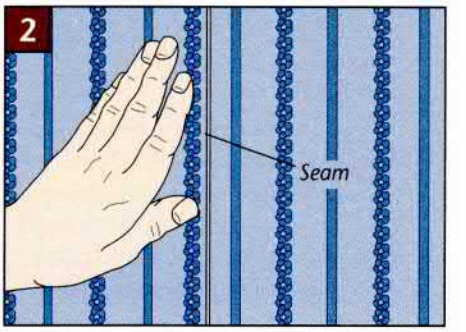
Repairing bubbles. Use a clean, damp cloth to moisten the area with the bubble. Using a utility knife or sharp razor blade, slit the bubble. Avoid making a straight cut—a V-shaped slit or one that follows the wallpaper's pattern will conceal the cut and make gluing easier.

With a narrow putty knife, force glue through the slit. Use a damp sponge to spread the glue so it completely fills the area beneath the bubble; press the wallpaper smoothly to the wall.

Repairing loose edges and tears

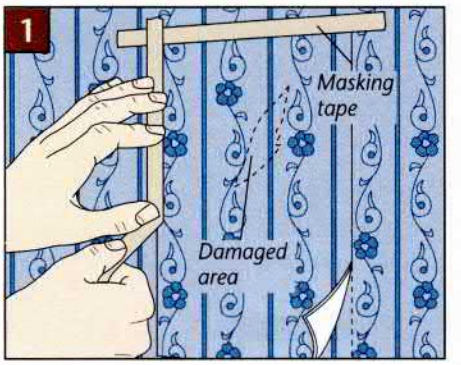


Moisten the damaged area and carefully lift the wallpaper away from the wall. Apply a thin, even layer of adhesive to the back of the loose paper.



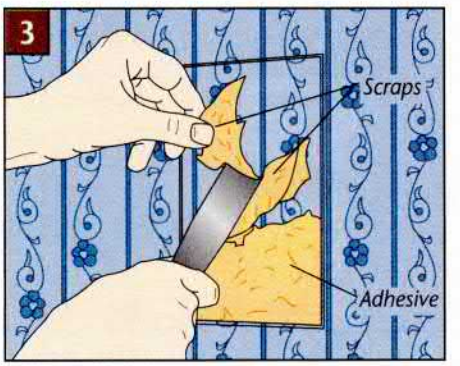
Press the wallpaper back in place. Sponge off any excess adhesive, taking care not to soak the paper so much that the adhesive loosens behind the paper.

Patching damaged wallpaper

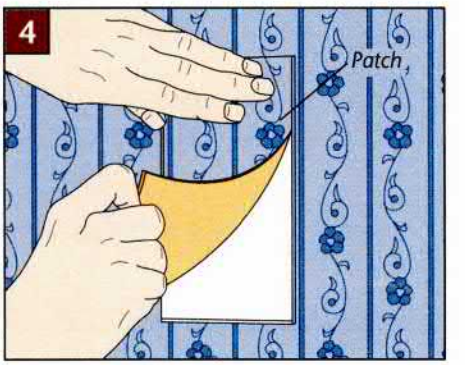


Align the replacement patch so the pattern exactly matches the pattern on the damaged section. Attach the patch to the wall with masking tape or tacks.

Cut through both the patch and the wallpaper underneath simultaneously, using a utility knife and steel straightedge. Remove the patch and set it aside.



Dampen the scored wallpaper with a wet sponge and peel it off. Scrape off scraps and adhesive with a putty knife. Clean the wall and let it dry.



Apply a thin layer of adhesive to the back of the patch. Position the patch carefully; smooth it with a clean, damp cloth or a seam roller. Wipe off excess adhesive.

PROFESSIONAL TIPS
CLEANING WASHABLE WALLPAPER

To remove dirt, grease, and stains from washable wallpaper, thoroughly sponge the soiled area with a solution of mild soap and cold water. Rinse with clear, cold water; wipe dry with a clean, absorbent cloth. NOTE: Test wallpaper before washing it.

CEILING TILES

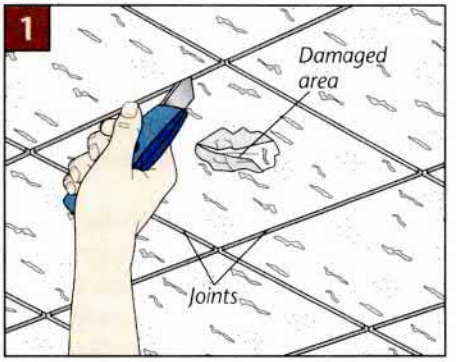
Prefabricated ceiling tiles are attached either to an existing ceiling or to furring strips. Staples or nails, either with or without adhesive, or adhesive alone secures the tiles.

Often, ceiling tiles show the effect of water damage. To conceal stains or streaks in tiles, apply a primer or clear sealer. When the tiles are dry, you can paint them with latex paint.

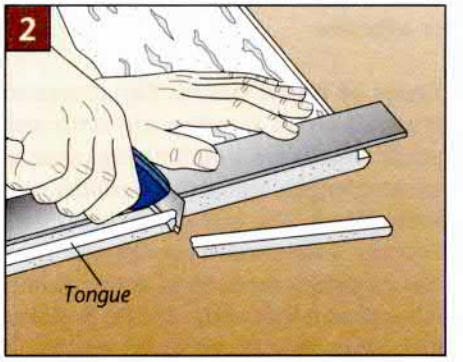
Another problem you may encounter is dents or chips in tiles. Illustrated below are the steps in removing and replacing a dented tile with tongue-and-groove edges. You cut through all four joints and pry the tile off its backing. Then pry out the cut-off tongues from the grooves in the adjacent tiles. Use pliers to remove any remaining staples or nails; scrape off adhesive.

After cutting the tongue off one side of the replacement tile, apply adhesive to the back of the tile or to the ceiling (follow the tile manufacturer's directions). Position the tile over the opening, slip the remaining tongue into the groove of an adjacent tile, and press in place until the adhesive holds; or use a floor-to-ceiling brace to hold the tile until the adhesive is dry.

Replacing a damaged ceiling tile



Cut through all four joints of the damaged tile; use a prybar to remove it.



Cut the tongue from one edge of the new tile using a utility knife and straightedge.

Apply adhesive; slip the tongue into an adjacent tile's groove and brace until dry.

Painting Over Wall Repairs

Applying a fresh coat of paint is a fast and effective way to conceal wall repairs. Depending on the size of the repair and the availability of matching paint, you may decide to paint just the repaired area, the whole wall, or the entire room.

Selecting paint and tools. The type of surface you're covering determines the kind of paint required. If you have paint left over from the original job, you're in luck. If not, refer to the chart at right for the appropriate paint. Note that because of environmental concerns, in many areas use of alkyd/oil-base paint is restricted. Check with your county extension office for local regulations.

Choosing the correct brush is important, too. The type of bristle should suit the paint or stain you're using; the brush size must fit the job. Select a natural-bristle brush to apply alkyd (oil) paint, varnish, or shellac. Use brushes with synthetic bristles to apply water-base (latex) paint. For wood stains, either a synthetic or natural-bristle brush can be used.

Choose a 1-inch brush for hard-to reach areas, a 2- to 3-inch brush for medium-size surfaces, and a 3 1/2- to 4-inch brush or a 9-inch roller for large areas, such as entire walls. Use a thick-napped roller for textured walls.

Preparing the surface. Before painting, you should sand and wash the surface. You may also need to apply a primer to ensure your repair will be less visible through the paint.

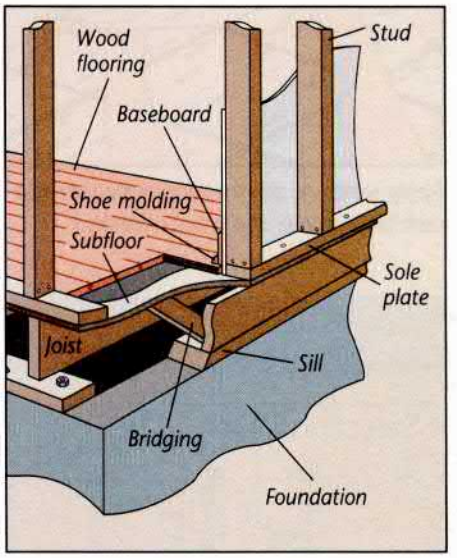
Paint Selection Guide

Surface	Latex flat/eggshell	Latex semigloss	Latex gloss	Alkyd flat/eggshell	Alkyd semigloss	Alkyd gloss	Wood stain	Varnish	Shellac
Gypsum board	•	•	•	•	•	•			
Plaster	•	•	•	•	•	•			
Wood paneling		•	•	•	•	•	•	•	•
Bathroom and kitchen walls		•	•		•	•			
Wood trim		•	•		•	•	•	•	•
Window sills		•	•		•	•	•	•	
Masonry	•	•							

WOOD FLOORING

A good wood floor will last the life of your home, but even the best wood floors are subject to damage or other problems. The problem may be in the surface flooring or related to defects in the supporting structure. To successfully repair the floor, it's important to know what type of flooring you have and how it is attached to the subfloor, as well as the cause of the damage or problem.

Flooring structure, types of wood flooring, and common problems are described below. On the following pages you'll find directions for repairing surface damage, fixing individual boards, replacing damaged sections of flooring, and silencing annoying squeaky floors from above and below.



Wood flooring is typically secured to a subfloor supported by joists and beams.

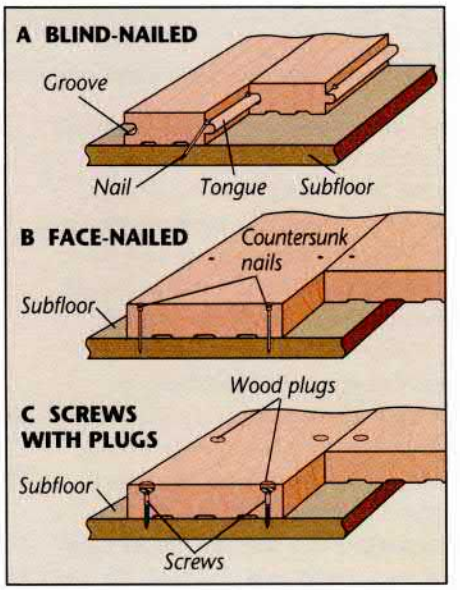
Flooring structure. A wood floor consists of a finished floor laid over a subfloor supported by joists and beams *(see illustration above)*. Joists may have solid or diagonal bridging between them to provide extra strength. Joists, beams, posts, and, in a two-story house, bearing walls carry the weight of the flooring material and subfloor and transfer it to the foundation.

The finished floor may be any of several hardwoods, such as red or white oak, maple, beech, or birch; or it may be made of a quality softwood, such as pine, fir, hemlock, or larch.

The subfloor is typically constructed from 1-by-4 or 1-by-6 lumber, or plywood panels. In a lumber subfloor, boards are laid diagonally across joists. A plywood subfloor has panels laid in a staggered fashion, with the ends butted together over and nailed to the joists.

If your house is built on a concrete slab, the floor may be laid over wood 2 by 4s (called sleepers) and nailed, or laid on a base of plywood and fastened with nails or adhesive.

Types of wood floors. Two common types of wood flooring are strip and plank. Boards for strip flooring come in random lengths and uniform widths, typically 1 1/2, 2, 2 1/4, and 3 1/4 inches. Plank flooring, a holdover from colonial days, was originally made from maple planks more than a foot wide. Today, it differs little from strip flooring, except that it comes in random widths—usually 3, 5, and 7 inches—as well as random lengths.



Wood flooring may be blind-nailed (A), leaving no visible signs of the nails, face-nailed with the nails countersunk (B), or attached with screws that are concealed under wood plugs (C).

In both types, board length usually ranges from 2 to 8 feet; most boards are 3/4 inch thick.

Both strip and plank boards may be milled with square or tongue-and-groove edges and ends, or with a combination of both. Depending on the milling, strip and plank floorings may be blind-nailed, face-nailed, or screwed to the subfloor *(see illustration at left below)*. Tongue-and-groove strip flooring is almost always blind-nailed; square-edged strip flooring is usually face-nailed. Tongue-and-groove plank flooring may be blind-nailed, screwed, or both; square-edged planks may be face-nailed, screwed, or both. Plugs usually indicate that flooring is screwed to the subfloor, though plugs are sometimes used just for decoration.

Common floor problems. Problems can range from minor surface damage to serious structural defects. Daily wear and tear causes surface scratches and gouges. The natural expansion and contraction of wood occurring with changes in temperature or humidity, as well as alternate drying and wetting due to leaks, can cause nails to pull out of the wood, allowing flooring boards to separate or warp; even the joists and the subfloor can separate. The natural settling of a house can also cause separations between the joists and the subfloor.

If your floor is sagging or uneven, there could be a serious structural problem; consult a professional.

Repairing the floor. You can repair most minor surface damage yourself. If your floor has separated, split, loose, or warped boards, first determine the cause and correct it if necessary; then make the repair *(see facing page)*.

If the damage is too extensive for a simple repair, you may need to replace boards or sections of flooring as described on pages 98-99. To eliminate squeaks in floors, you can choose one of several methods, from lubricating the squeak with graphite to installing wood shims *(page 100)*.

Repairing Wood Floors

Surface damage, as well as separated, split, loose, or warped boards, can be repaired successfully. To preserve the beauty of your wood floors, make repairs immediately after damage occurs. When refinishing the repaired area, match its color and protective finish as closely as possible to its surroundings to hide the repair.

REPAIRING SURFACE DAMAGE

In most cases, you'll have to remove the protective wax or oil finish from the damaged area with a wax stripper. Once you complete the repair, rewax or oil the area. When stripping and rewaxing, follow the product manufacturer's directions.

Water marks. After removing the protective finish from the surface, rub the marks with fine steel wool and a little paste wax or a solvent-base liquid floor wax. If the marks don't disappear, wipe the wax with a soft cloth and rub again with fine steel wool and odorless mineral spirits. Wipe clean and finish.

Burn marks. For burn marks that just darken the wood's surface, lightly sand; wipe up sanding residue with a damp cloth. When dry, finish as desired.

For burns that go deeper, carefully scrape out the burned wood with a sharp knife. Apply one or more coats of a commercial scratch hider, putty stick, or stick shellac; then finish.

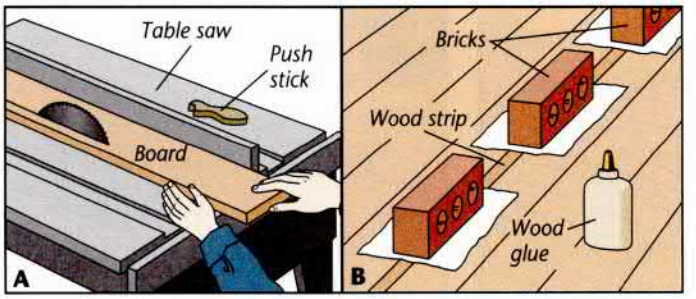
Scratches and gouges. You can conceal a shallow scratch with one or two applications of a commercial scratch hider or crayon. To repair deep scratches and gouges, remove wax or oil from the damaged area. Fill the scratch or gouge with matching wood putty, putty stick, or stick shellac. Let dry; then sand smooth with fine-grade sandpaper and finish.

FIXING DAMAGED FLOOR BOARDS

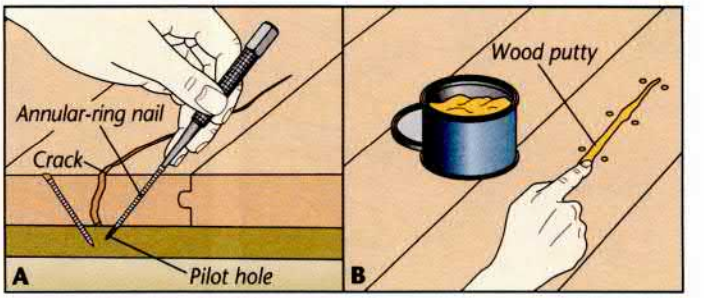
For long or wide separations between boards, fill the gaps with wood strips *(see below)*. For the best possible fit, angle the saw blade to cut strips that taper in slightly at the bottom.

Loose, split, or warped boards can be satisfactorily repaired, as shown below. Sand any putty when it's dry with fine steel wool and finish the repair to match the rest of the floor.

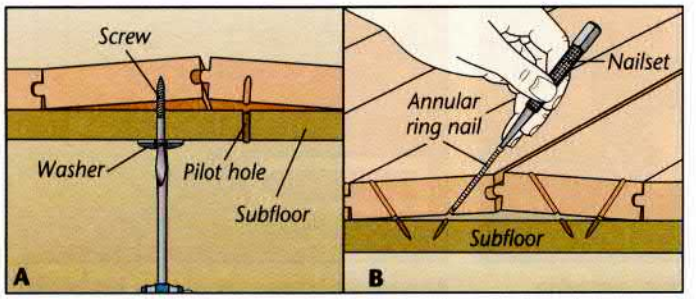
Four types of board repairs



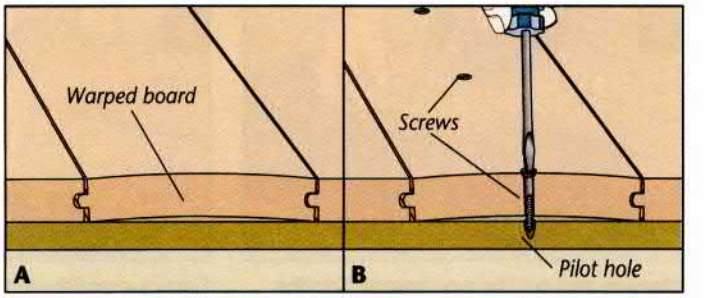
Separated boards. Measure the gap between boards; transfer the measurements and cut a wood strip from a new board (A) using a table saw. (Note: Blade guard omitted here for clarity.) Glue the strip in the gap; weight it until the glue dries (B).



Split boards. Drill pilot holes at an angle every few inches along the length of the crack. Drive and countersink annular-ring nails (A). Fill the nail holes and crack with wood putty (B). Finish to match the rest of the floor.



Loose boards. From below: Drill pilot holes through the subfloor and just into the boards; insert screws (A). From above: Drill pilot holes; drive and countersink nails (B), fill with wood putty, and finish.



Warped boards. To fix a badly warped board (A), drill pilot holes every few inches along the board. Insert and tighten screws (B); fill the holes with wood putty and finish.

Replacing Wood Flooring

If floor damage is too extensive for the remedies on pages 96-97 and 100, you may need to replace some boards.

Ideally, replacing boards will be one step in an overall floor-refinishing project. If not, you'll have to take special care to match and finish the replacement boards. To ensure a good match, take the old boards when you shop for replacements. With plank flooring, make a drawing of the damaged area, showing the dimensions of planks you're removing.

Before replacing flooring, look for evidence of the nailing method. In blind-nailing, nails are driven through the tongue of each board and they don't show on the finished surface. Dots of wood putty indicate face-nailing. Plugs on plank flooring often cover screws; if the plugs are just decorative, the flooring is blind-nailed (some flooring that is secured with plugged screws may be blind-nailed as well). For any of these floorings, you can use one of two approaches.

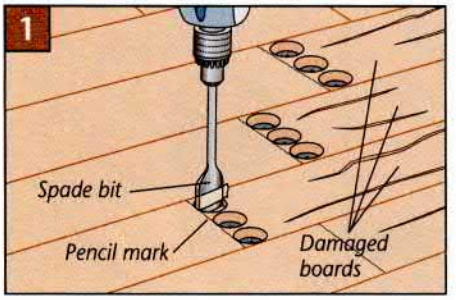
One approach, shown below, is to remove the damaged boards in a staggered pattern. This produces a less noticeable repair and is best for replacing boards in an open floor area. The other approach *(see facing page)*, good for areas that will be covered by a rug or furniture, is to cut out a rectangle, remove the damaged boards, and replace them.

Illustrated here are directions for replacing blind-nailed tongue-and-groove boards. You'll follow the same general sequence to replace other types of flooring, but because they're attached differently to the subfloor, take note of the special instructions that follow.

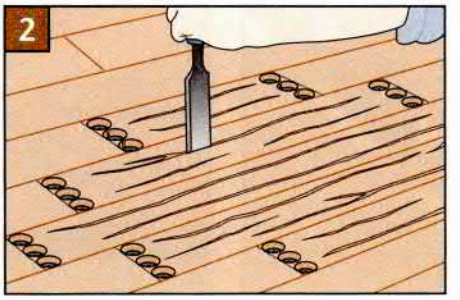
Face-nailed straight-edged boards. Use a nailset to drive the nails through the boards and into the subfloor. If you're using the rectangular pattern, cut only the ends of the boards. Starting at one end, use a prybar to remove them. For the staggered pattern, see below.

Cut the new boards to size and lay them in place; use a hammer and 2-by-4 wood block to tap the last one into place. Face-nail boards to the subfloor, matching the nail pattern in the original flooring. Countersink the nail heads with a nailset and hammer; fill the holes with wood putty. After the putty is dry, sand the putty flush with the surface of

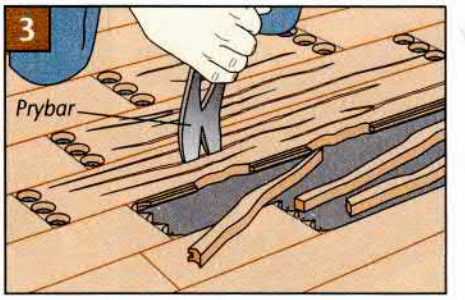
Replacing tongue-in-groove boards (staggered)



Mark cutting lines on the damaged boards. Using an electric drill with a large spade bit, drill a series of holes just inside the lines (be careful not to drill into the subfloor).

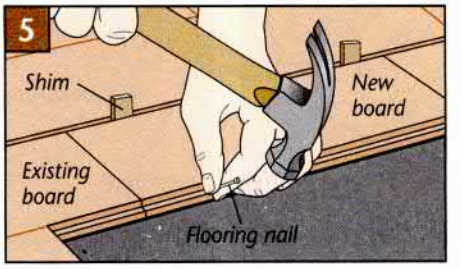


Split the detective area of each board, using a large wood chisel and hammer. Tap the chisel lightly to avoid splitting or cracking the surfaces of adjacent boards.

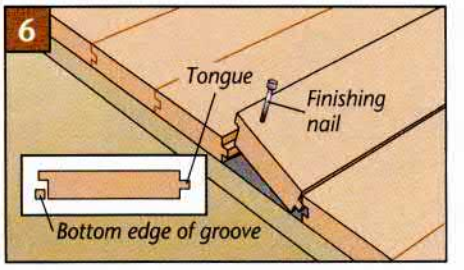


Pry out split lengths of boards; use a small wood block for leverage, if needed. Carefully trim the board ends square, using a wide, sharp-bladed wood chisel and a hammer.

Measure and cut the new boards. Slip the first board's groove over an existing one's tongue. Tap in place with a mallet and wood scrap; then blind-nail.



Continue positioning boards, removing tongues where necessary. Blind-nail in place. Use shims to align the new boards' edges with the existing ones.



Remove the bottom edge of the last board's groove. Insert tongue-side first; press in place. Face-nail at each end. Countersink nails, fill holes, and finish.

the boards and finish the area to match the existing flooring.

Plugged planks. Mark off the cutting area; drill out the wood plugs down to the screw heads; then remove the screws. If your planks are also face-nailed (look for dots of wood putty), use a nailset and hammer to drive nails through into the subfloor.

To cut a rectangular pattern, set the blade of a circular saw to the thickness of the planks and cut the four sides. Carefully pry off the planks. To remove planks in a staggered pattern, follow Steps 1-3 on the facing page.

Mark and cut replacement planks. Using the plugs in the existing planks as guides for spacing and diameter, mark the locations of screw holes on the ends of each replacement plank and on the ends of each existing plank adjacent to the opening. At each location, use an electric drill with a combination bit to drill a hole for the plug and a pilot hole for the screw shank *(page 15)*.

Lay the planks one at a time; fasten the screws. Daub glue in the plug holes and seat the plugs, removing excess glue. When the glue is dry, sand the plugs and finish the new boards to match the old.

QUICK FIX-UP

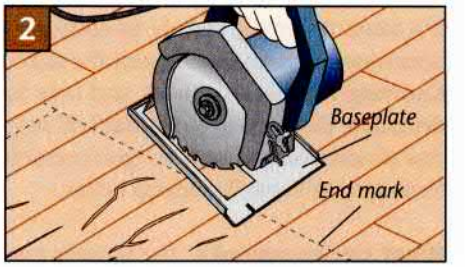
CARING FOR WOOD FLOORS

To clean minor spots and stains from a wood floor, wipe the floor with a barely damp sponge mop. If the stains remain, use a mild cleanser, such as a solution of ammonia or white vinegar, to remove them. Rinse the floor with a clean, damp (not wet) sponge mop to remove any residue.

To restore the floor's luster, buff it lightly; wax, if necessary, and buff again. In general, vacuum or dry-mop flooring about once a week; wax once or twice a year.

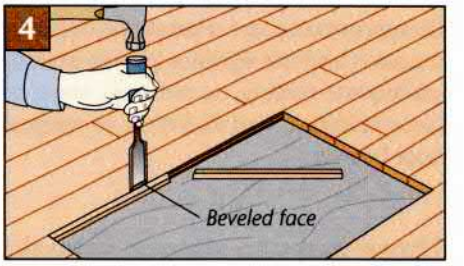
Replacing tongue-and-groove boards (rectangular)

Mark area to be cut with a pencil and steel square. Make side marks 1/4 inch from joints so saw won't hit any nails.

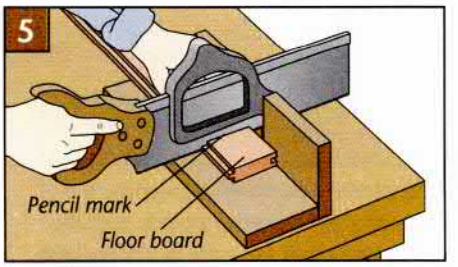


Adjust the blade depth of a circular saw to the boards' thickness (test with a drill). Start cuts in the center; work toward ends.

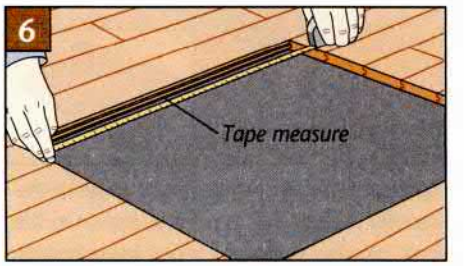
Lift boards with a prybar, starting at the mid-point of a side cut. Use a wood block for leverage and to protect the floor.



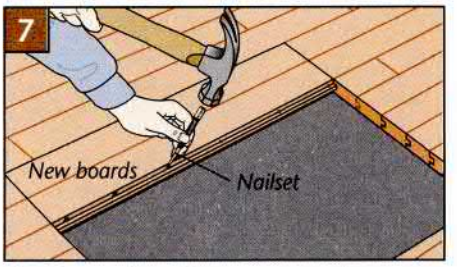
Cut away the 1/4-inch edges outside the saw cuts using a hammer and wood chisel. Countersink exposed nail heads.



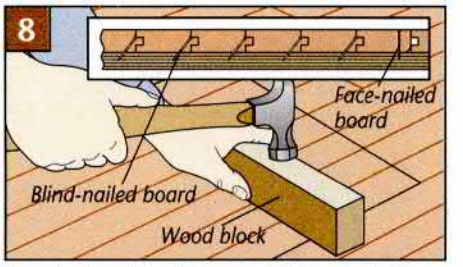
Cut one end of each new board at a 90° angle; use a backsaw and a miter box to make the cuts.



Lay each board in place, fitting the cut end tightly. Mark the other end and saw on the waste side.



Slip the new board's groove over the tongue of the board in place; blind-nail. Remove the last board's tongue.



Tap the last board down and face-nail the ends. Countersink nails, fill holes with wood putty, and finish.

Silencing Squeaky Floors

It's often relatively simple to eliminate floor squeaks once you pinpoint the cause. Knowing why floors squeak and how to determine the cause of the squeak will help you choose the appropriate repair method from among those illustrated below.

What causes squeaks. The squeaks you hear when you walk occur when pieces of wood rub together. Squeaks in wood floors can originate in the finished floor itself or in the subfloor, joists, or other parts of the supporting structure *(page 96)*. Common causes are separations between the joists and the subfloor (due to drying, inadequate nailing, or settling), weak or loose bridging, and ill-fitting or warped floor boards.

Locating squeaks. In a house where the joists are visible from the basement or the crawl space, you'll be able to pinpoint the squeaks more easily than you will in homes where joists aren't exposed or where it's an upper floor making the noise.

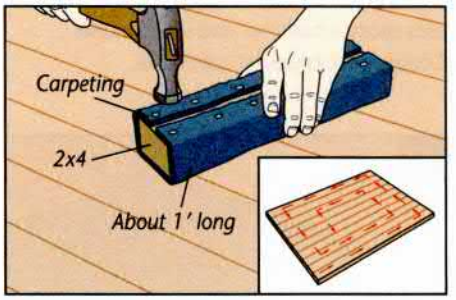
If joists are exposed, watch from below while another person walks across the floor above; you should be able to detect the probable cause of the squeaks. For example, you might spot some slight movement between the joists and the subfloor or perhaps loose bridging between two of the joists. If the joists are not exposed, however, you will have to confine your investigations to the finished flooring itself.

Correcting squeaks. Simple remedies include squirting powdered or liquid graphite between boards or dusting cracks between boards with talcum powder. You can also apply floor oil to the floor or a few drops of mineral oil between boards. (Use mineral oil sparingly; too much can stain the surface of the floor.)

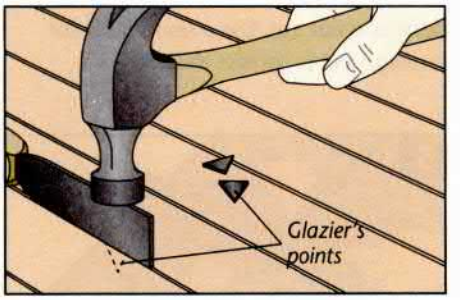
If the squeaks are from ill-fitting or warped boards, you can often fit them from above. Work wood putty between boards or try one of the remedies below.

Where joists are exposed, you can work from underneath. Toenail loose bridging *(page 96)* or tighten other loose areas using the techniques below. When working on boards from below, wear eye protection to protect yourself from falling debris.

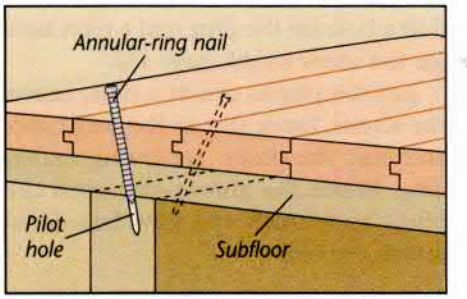
Three ways to silence squeaks from above



Place carpeted 2-by-4 at a right angle to the squeaky boards and move it as shown in the inset, tapping sharply to reseat loose boards.

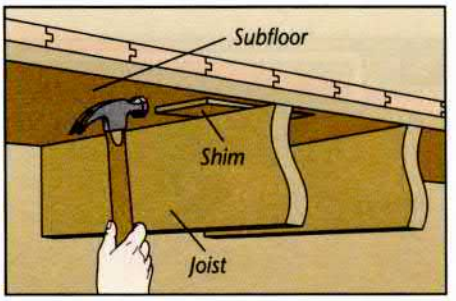


Coat glazier's points with graphite, then hammer them between boards. Sink the points well using the edge of a putty knife.

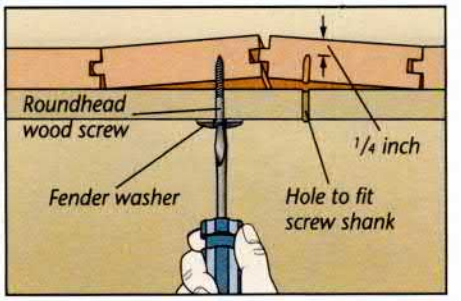


Drill angled pilot holes through the board into the subfloor and, if possible, into a joist. Drive in nails, countersink, and fill.

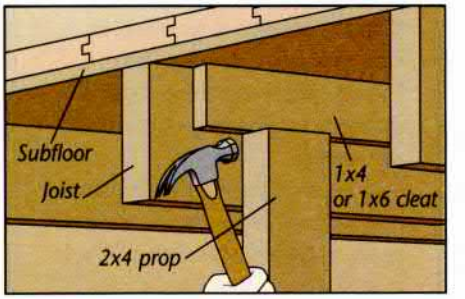
Three ways to silence squeaks from below



Tap a shim into the gap between a joist and the subfloor. Don't force it or you may widen the gap.



Drill holes slightly smaller than screw threads; install washers and wood screws (1/4 inch shorter than the total floor thickness).



Mount a cleat against a joist under loose boards; prop and tap so the cleat is snug against the subfloor. Nail to the joist.

RESILIENT FLOORING

The family of floor coverings described as resilient flooring includes linoleum, cork, polyurethane, vinyl, rubber, and asphalt materials. Resilient flooring comes in individual tiles or in sheets up to 12 feet wide. Both types are usually laid in solvent- or water-base mastic on concrete, plywood, or hardboard; some tiles are self-sticking.

Resilient floors are flexible, resistant to moisture and stains, and easy to maintain. Even so, they can become scratched, stained, or gouged, and they may even develop bumps, bubbles, or curled edges. These may be minor surface problems or they could be indications of problems in the subfloor.

Before you try to repair or replace damaged sections of resilient flooring, you'll need to determine the cause of the damage and, if necessary, correct it. Then you can either touch up the surface to conceal the flaws or patch or replace the damaged area. If you must replace flooring, take care to match materials and adhesives *(see at right)*.

Evaluating the damage. The cause of most surface damage—such as stains, scratches, gouges, or holes—is usually readily apparent. But often, some minor surface damage can be caused by somewhat more serious problems in the subfloor or supporting structure.

A regular pattern of indentations, running for several feet or forming Ts, may be caused by separations in the subfloor due to shrinkage of the wood or settling of the structure. If you see signs of this type of damage, you'll have to remove the floor covering before you can make the necessary repairs to the exposed subfloor below.

Small bumps that appear in the surface of the floor may be caused by nails that have worked loose. Over a period of time, movement in the structure can cause the subfloor to separate from the joists, forcing the nails up into the resilient flooring. Or, if the original tiles or sheet material was installed when there was too much moisture in the subfloor, the nails may have worked loose as the damp wood dried.

You can place a wood block over the bumps and tap it lightly with a hammer to sink the nail heads flush. If this doesn't work, you'll have to remove the floor covering to gain access to the subfloor.

Then replace nails with flooring screws. If tiles have curled at the edge or popped loose in one area, you may have a minor plumbing leak. Stop the leak *(page 133)* before you fix the flooring. Moisture can also cause sheet vinyl to work loose around the perimeter of a room. Moisture in the floors of rooms at or below grade level often results from poor drainage outside *(page 50)*, a problem you'll have to solve before repairing the flooring.

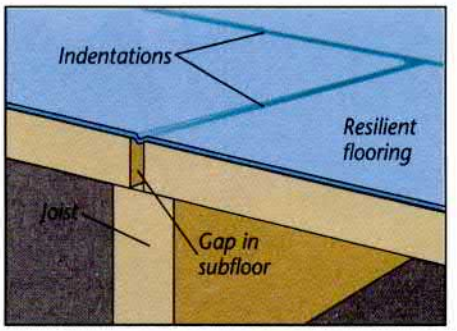
Repairing or replacing flooring. You can make most minor surface repairs effectively using the tools and techniques shown on page 102. If damage is more extensive, you'll have to remove and replace a tile or even patch a section of sheet flooring *(pages 102-103)*.

Matching materials and adhesives. If you have material left over from the original installation or if the floor is relatively new and the material is still available, it's likely you'll be able to make a satisfactory match. But a patch on old or worn flooring may be conspicuous. If so, consider using a complementary or even contrasting color or design. If you can't make repairs that are visually acceptable, consider recovering the entire floor.

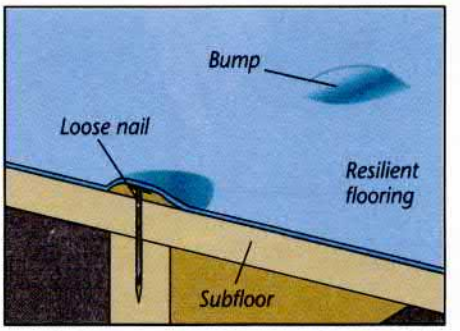
When you repair or replace resilient flooring, use the adhesive specified by the flooring manufacturer. If you're sure of the type of flooring you have, a flooring materials supplier can tell you what adhesive is recommended; if you're not sure, take a sample of the flooring with you. Also be prepared to tell the supplier what kind of subfloor you have.

Before working with a solvent-base adhesive, check the container to find out what solvent is recommended for cleaning up smudges or any stubborn adhesive that remains after the damaged flooring has been removed. Have the solvent on hand.

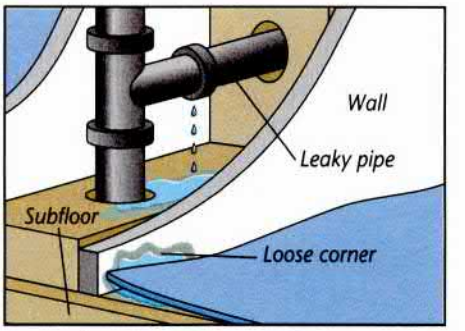
Three causes of surface flaws



A regular pattern of indentations. (Sometimes these are in the shape of a T.) Cause: Separations in the subfloor caused by shrinkage or settling.



Small bumps. Cause: Loose nails caused by structural movement or moisture in the subfloor that pushes nails up as wood dries.



Loose flooring edges or tiles. Cause: Moisture from a pipe leak or, in rooms at or below grade level, poor outside drainage.

Repairing Resilient Tile

Minor stains or surface damage on resilient tile can be easily corrected, but more serious damage may mean replacing one or more tiles.

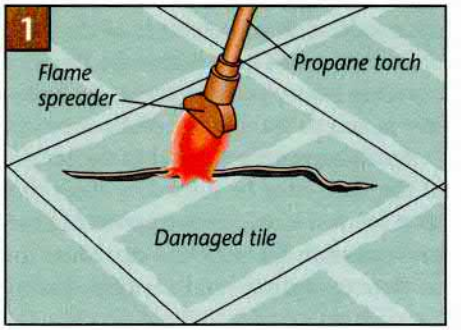
To remove surface stains, see the facing page. For refastening curled tiles or repairing bubbles or small holes, see below.

If a tile is badly scratched or gouged, you'll have to take it up and replace it as shown at right. If you have an exact match, the repair will be almost invisible, as long as existing tiles aren't discolored.

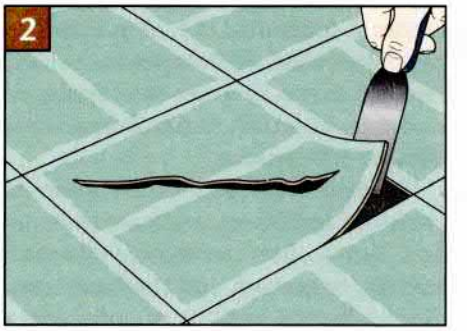
To remove the damaged tile, you'll need a propane torch with a flame spreader (an iron or heat gun can also be used); with a stiff putty knife, lift up the damaged tile and remove the adhesive. When you've removed the tile, let the adhesive cool and harden (it will take about an hour) before you scrape it away. Check that the subfloor is smooth and flat. Set the replacement tile in the same type of adhesive that was used in the original installation or in a solvent-base adhesive.

Be sure the new tile is level with the adjacent ones. If it's too low, lift it up and apply more adhesive. If it's too high, press it down to squeeze out excess adhesive. Use the recommended solvent to remove excess adhesive and let the adhesive dry completely before walking on the floor.

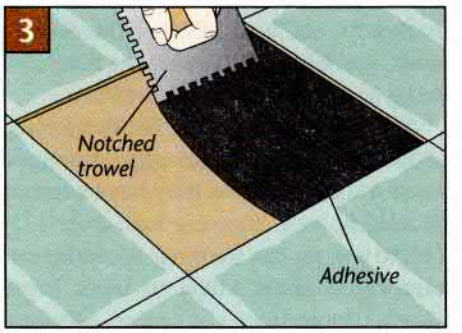
Replacing a damaged tile



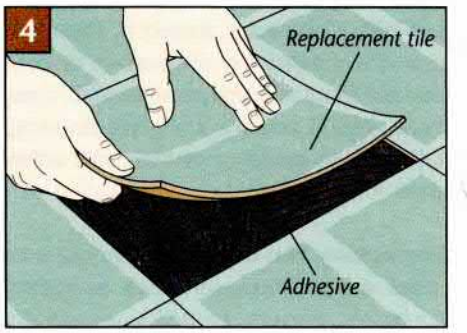
Use a propane torch with a flame spreader to soften the adhesive under the tile (tile should be warm but not too hot to touch). Keep a fire extinguisher nearby.



Pry up a corner of the tile with a putty knife; free the tile. When the adhesive hardens, scrape it up so the subfloor is smooth and clean.

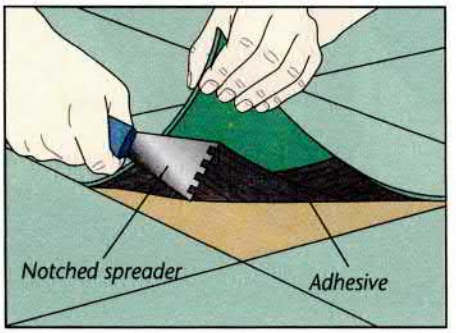


Spread a thin, even layer of adhesive on the subfloor using a notched trowel (follow the adhesive manufacturer's directions). Avoid getting any adhesive on adjacent tiles.

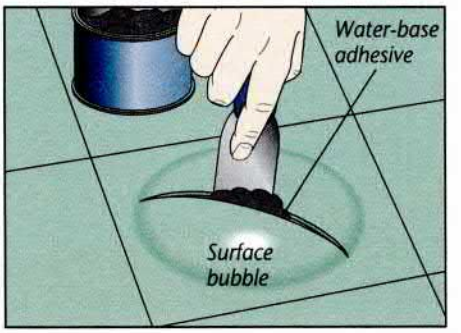


Butt two adjacent edges of the new tile against two adjacent tiles, matching the pattern, if any. Press the tile in place, remove any smudges with solvent, and let dry.

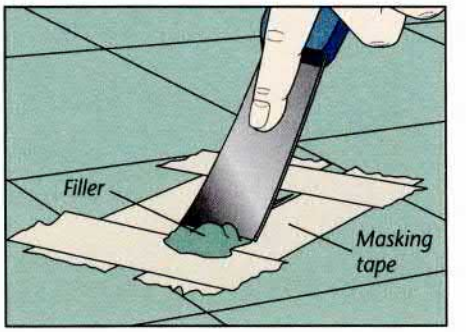
Three repairs for common surface damage



Curled tile. Soften the adhesive with a warm iron; scrape it off the subfloor with a putty knife. Apply adhesive to the tile with a notched spreader and weight tile overnight.



Bubble. Soften with a warm iron; slit the bubble edge to edge with a utility knife. With a putty knife, force water-base adhesive inside. Press flat and weight overnight.



Small hole or gouge. Apply a filler made of powdered leftover flooring and a few drops of clear nail polish. (Tape the surrounding area.) Buff with fine steel wool when dry.

Repairing Sheet Flooring

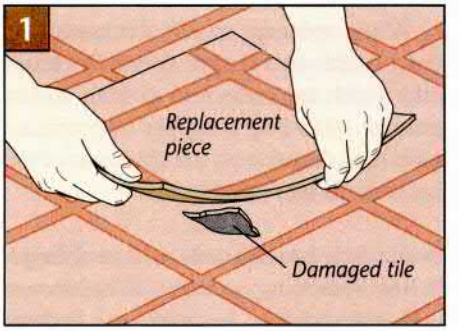
If your sheet flooring is stained or has suffered minor surface damage, such as bubbles or small holes, see the repair instructions below and on the facing page. If the damage is more serious, you can patch the area with a new piece of flooring *(see at right)*.

In patching, the trick is to match the patch to the existing floor. If you decide to patch rather than lay all new flooring, you'll need a replacement piece larger than the damaged area.

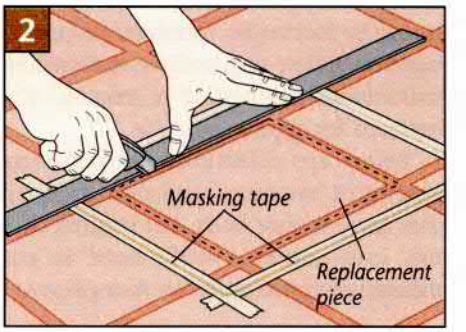
When you position the patch, be careful to align the pattern on the patch with the pattern on the existing flooring. Use a sharp utility or linoleum knife and a steel straightedge to cut through the flooring; you'll need a putty knife to pry up the damaged area and scrape off the old adhesive on the subfloor. If necessary, apply adhesive solvent to remove the damaged flooring and the old adhesive.

To set the new patch, use solvent-base adhesive or the adhesive used in the original installation. The patch must be level with the existing floor. If the patch is too low, lift it up and apply more adhesive. If it's too high, press it down to squeeze out excess adhesive. Use the recommended solvent to remove excess adhesive. Follow the adhesive manufacturer's directions for drying time.

Repairing loose edges and tears

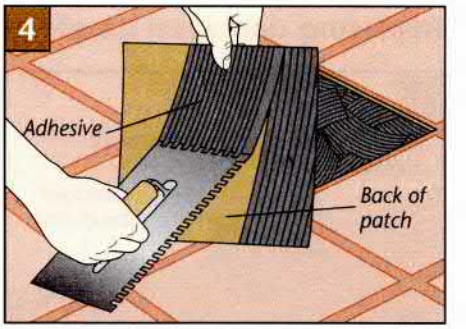


Cut a piece from leftover flooring with a sharp utility knife, making sure the piece is large enough to cover the damaged area and matches the floor's pattern.



Tape the piece to the floor with masking tape, matching the pattern carefully. Use a utility knife and straightedge to cut through the patch and old flooring.

Set the patch aside. Use a putty knife or cold chisel to pry up the old flooring and chip out the adhesive, being careful not to mar or cut the existing flooring.



Spread adhesive on the patch with a notched trowel; press the patch firmly in place so it's level with the existing flooring. Remove smudges with solvent.

Removing Stains from Resilient Flooring

To prevent stains in resilient tile and sheet flooring, wipe up spills promptly. Stubborn stains or stains that have set require a bit more work, and may even call for some experimentation.

First, try to remove the stain by wiping with a clean cloth moistened with liquid-detergent floor cleaner (use a nylon pad for heavy residue).

If detergent doesn't remove the stain, try the following products, one at a time and in order: rubbing alcohol, liquid chlorine bleach, turpentine, nail polish remover, and lighter fluid. CAUTION: Do not apply nail polish remover to vinyl; turpentine, nail polish remover, or lighter fluid to asphalt or rubber tile; or chlorine bleach to cork.

Apply each product with a clean white cloth, turning the cloth frequently. Don't walk on the treated area for 30 minutes. When the stain is gone, rinse the area with water and let it dry; reapply floor finish, such as vinyl floor polish or wax, if it's normally used.

Avoid using abrasive scouring powders or pads on resilient flooring, no matter what type you have. Before using any cleaning product, in fact, it's a good idea to test it on an inconspicuous area. If you're in doubt about what cleaning product to use on your floor, consult your flooring dealer.

BASEBOARDS & SHOE MOLDINGS

Installed where the floor and walls meet, baseboards (also called base moldings) and shoe moldings hide uneven floor and wall joints and protect walls from damage caused by foot traffic, furniture, and cleaning tools. Often, they become so dented or marred that they need to be removed and replaced for appearance sake.

Below are directions for replacing lengths of baseboard and shoe molding that have square ends. For lengths that run into corners, you'll have to cut mitered or coped ends *(see facing page)*.

Buying materials. When you shop for replacement sections, take pieces of the old ones with you to ensure a good match. Wood baseboards and shoe moldings come in many standard patterns and sizes and several finishes. If your ones are old, though, you may have to get specially-milled replacement sections.

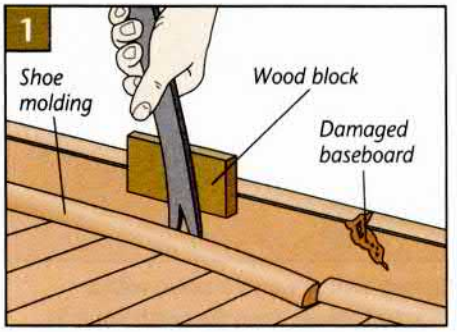
When ordering, specify thickness first, then width and length (both thickness and width are measured at their widest points). Also buy a supply of finishing nails (size depends on the thickness of the baseboards and moldings).

Replacing baseboards and moldings. When removing sections of baseboard and shoe molding, be careful not to damage the wall behind them. To protect the wall, use a wood block behind the prybar as you work *(see illustrations below)* and pry only at studs.

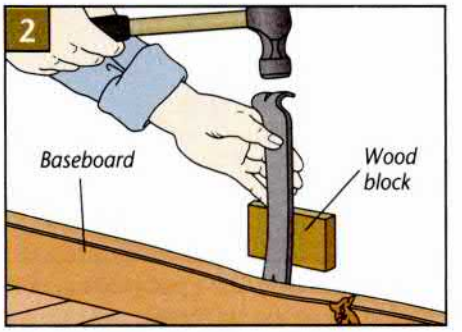
Begin by inserting the thin end of a broad-bladed prybar between the baseboard and shoe molding. Pry outward along the molding to loosen it, then grasp the molding and pull it carefully away from the baseboard.

To remove a length of baseboard, insert the thin end of the prybar between the baseboard and wall. Pry outward to create a gap between the wall and baseboard. As the baseboard comes loose, insert wood wedges in the gap. Continue prying and inserting wedges until the length of baseboard is fairly loose. Then pry with one hand, grab the baseboard with the other, and yank it away from the wall. Remove any nails that remain in the wall, shoe molding, or baseboard.

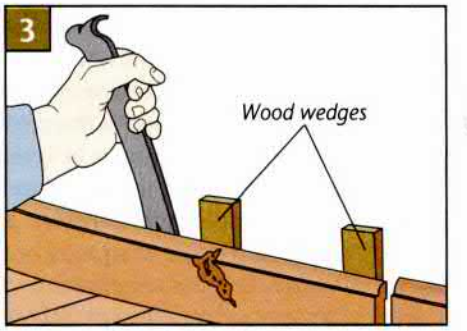
Replacing damaged baseboard



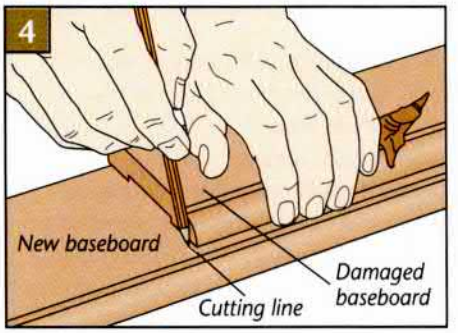
Insert the thin end of a broad-bladed prybar between the shoe molding and baseboard; loosen the molding by prying outward. Pull the molding free; remove nails.



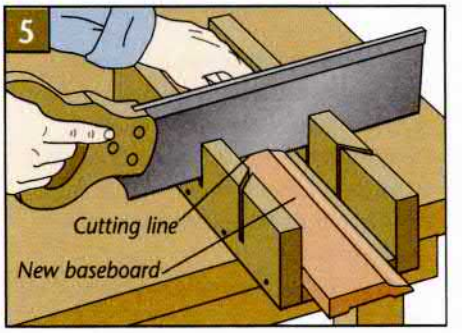
Place the thin end of the prybar between the baseboard and wall (use a wood block to protect the wall) and pry outward to make a gap.



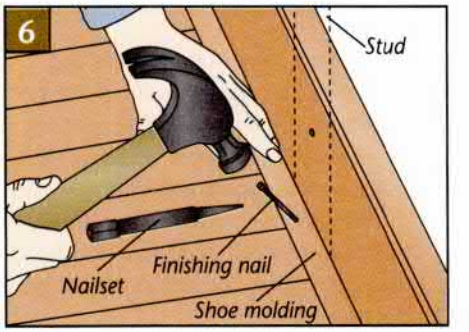
Insert wood wedges in the gap as you pry. When the baseboard is loose pull it free. Remove remaining nails from the baseboard and wall with pliers or a hammer.



Measure the replacement baseboard and shoe molding against the damaged pieces; mark cutting lines with a pencil. For corners, see the facing page.



Use a miter box and backsaw to cut the replacement baseboards and shoe moldings. Saw the pieces on the waste side of the cutting lines.



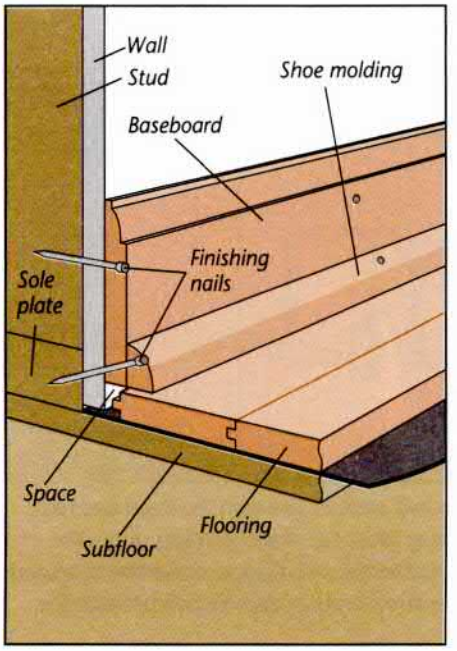
Position the baseboard; drive nails at each stud location. Position the shoe molding and nail into the sole plate at each stud. Sink nails, fill, and finish.

Measure the replacement baseboard and shoe molding against the damaged ones for fit. Mark cutting lines with a pencil. To cut replacements, use a miter box and backsaw. Holding the wood steady, saw on the waste side of the cutting line.

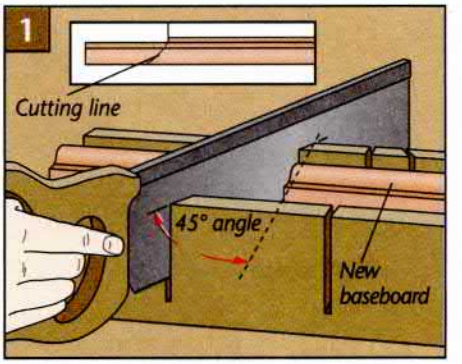
Place the new baseboard against the wall. Drive finishing nails through the baseboard and into each stud. Then position the shoe molding against the baseboard and drive finishing nails through the molding at an angle into the sole plate at each stud location. Use a hammer and nailset to sink nail heads, and fill the holes with wood putty. When dry, sand the putty smooth. Finish the baseboard and shoe molding as desired.

Cutting and fitting corners. When you're replacing two lengths of baseboard that meet at an outside corner, you'll have to miter the ends of both pieces and install them as shown at right above. If the ends of the baseboards you're replacing meet at an inside corner, cope the end of one replacement to fit over the other *(see at right)*. Cut and fit the ends of both shoe-molding pieces in the same way.

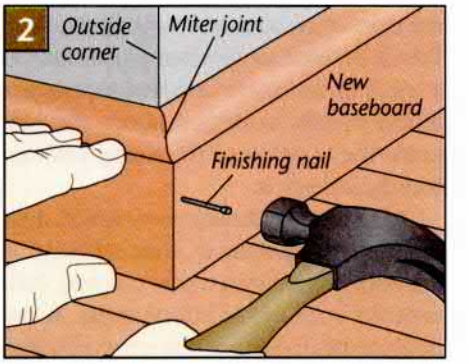
Anatomy of a baseboard



Installing an outside corner

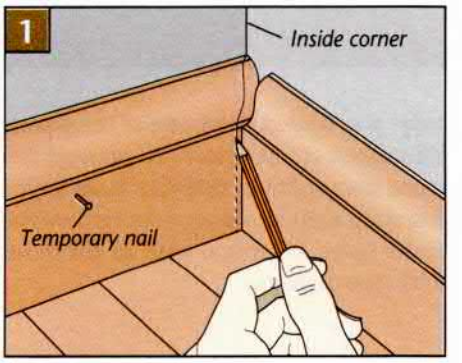


Use a miter box and a backsaw to cut the replacement baseboard at a 45° angle after measuring the new pieces against the damaged ones and marking cutting lines.

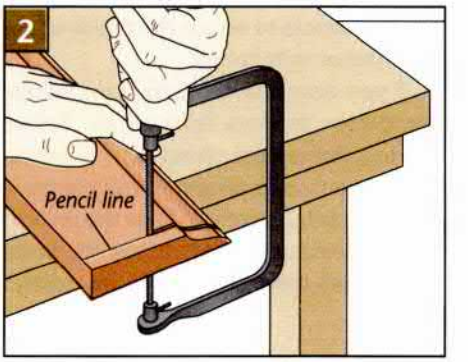


After nailing one new piece in place, butt the end of the second baseboard section against it and drive two nails through the joint. Sink the nails, fill the holes, and finish.

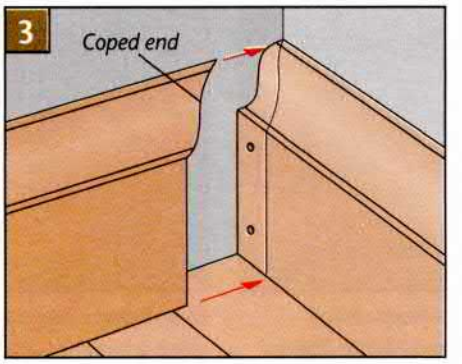
Installing an inside corner



Temporarily nail the new piece that you want to cope in the corner. Butt the end of the other new piece against it and trace the outline with a pencil.



Remove the marked piece; holding the piece steady, use a coping saw *(page 17)* to cut carefully along the pencil line.



Nail the uncoped piece in place; then cut the coped piece to length. Butt it against the uncoped piece and nail it in place.

Drive nails through the baseboard and into the studs and sole plate. Sink the nails, fill the holes, and finish.

STAIRS

Squeaks in stairs are usually caused by a loose tread rubbing against a riser or the stringers when someone steps on the stair. Treads become loose when joints open as a result of shrinkage or when supporting blocks or nails work loose. Once you pinpoint the location of the noise, you can usually remedy it.

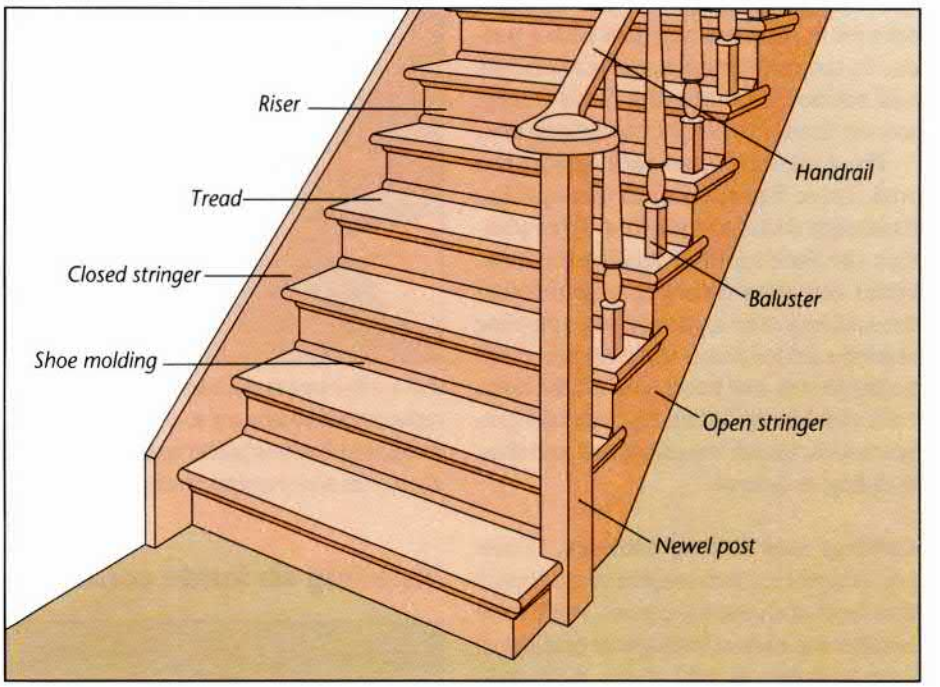
You probably already know which steps are the noisemakers in your staircase. If the noise comes from where you step, concentrate your repair efforts there. If the noise comes from one side when you step in the center or if it comes from the rear of the tread when you step at the front, first secure the place where you step, then move to the apparent source of the noise.

If the stairs are accessible from underneath, work on them from below so your repairs won't show. (Be sure to wear eye protection.) You can use wedges, brackets, or wood blocks to secure the treads to the risers *(see at right below)*.

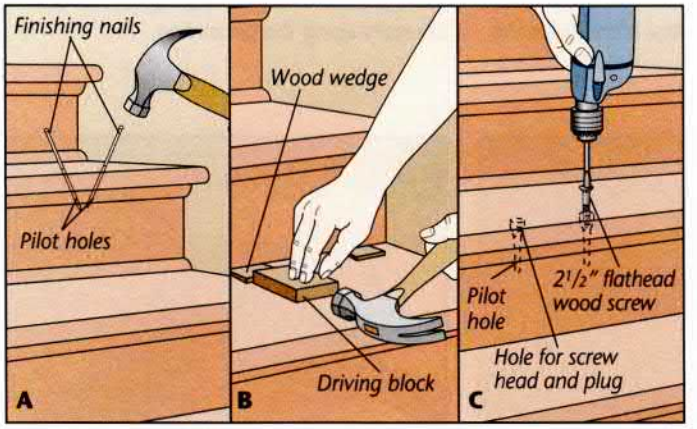
If you don't have access from below, you'll have to work from above. Before making any repairs, though, try lubricating the stairs with talcum powder or powdered graphite. Forcefully blow the powder into the joints, especially where the backs of the treads meet the risers. If this doesn't help, you'll need to try one of the repairs illustrated at left below. To prevent the wood from splitting, drill pilot holes before inserting nails or screws; counterbore the holes *(page 15)* if you plan to fill them with dowel plugs.

If you drive in wedges, you'll have to remove any shoe molding first. After driving in the wedges with a hammer as shown at left below, cut them flush with the risers using a utility knife and replace the shoe molding to hide them from view.

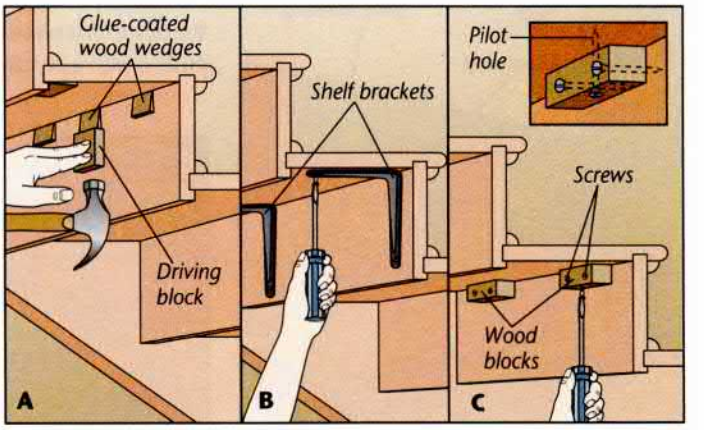
Parts of a staircase



Six ways to fix squeaky stairs



From above: Drive and sink nails into angled pilot holes drilled through the tread into the riser (A); cover with wood putty. Tap in glue-coated wedges between the tread and riser (B); trim and cover with molding. Insert screws into pilot holes drilled through the tread into the riser (C); glue in dowel plugs.



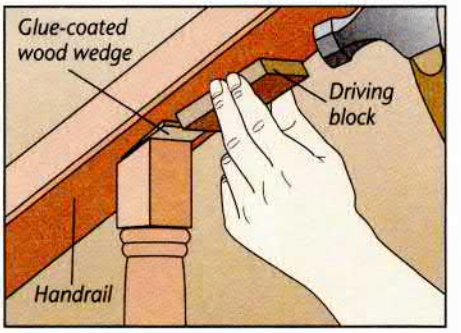
From below: Tap glue-coated wedges between the tread and riser, using a hammer and driving block (A). Install brackets under the tread and riser (B). Glue and screw wood blocks under the tread and against the riser; keep the screw ends at least 1/4 inch beneath the tread surface (C).

BANISTERS

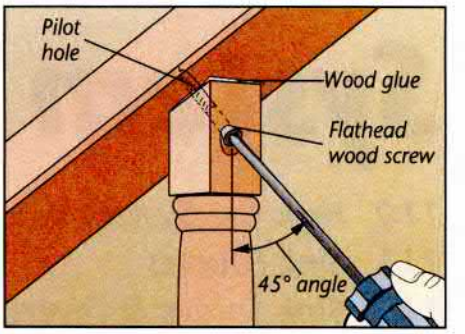
Wood banisters generally consist of one or two handrails, balusters, and one or more supporting newel posts *(see facing page)*. Use over a long period can weaken the banister, resulting in loose handrails, balusters, or posts.

Methods for tightening loose parts involve inserting wedges or securing loose parts with screws. If you're using screws, drill pilot holes for them to prevent the wood from splitting. Use an electric drill with a combination bit *(page 16)* so you can sink the screw heads. To conceal them, fill the screw holes with wood putty—preferably colored to match the wood—and sand the putty smooth.

Two ways to tighten a loose handrail

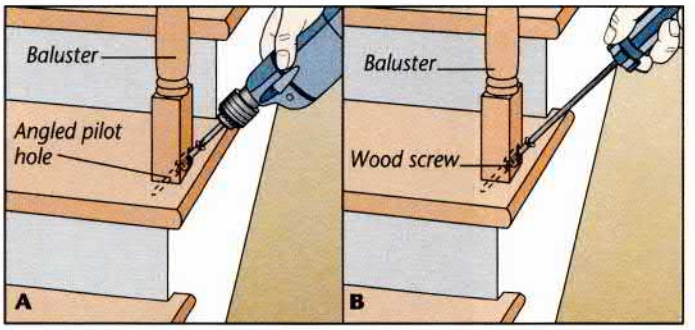


Wedges. Tap glue-coated wedge between the handrail and baluster (don't pry up the handrail). Using a utility knife, trim the wedge flush with the baluster.

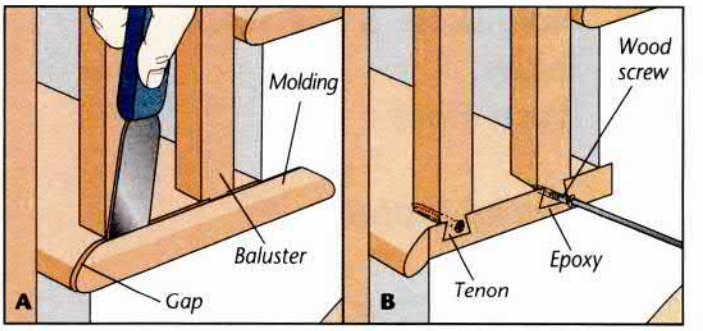


Screws. Drill an angled pilot hole through the baluster and into the handrail; countersink the screw. Apply wood glue; insert screw and tighten. Fill hole, sand, and finish.

Two ways to tighten a loose baluster

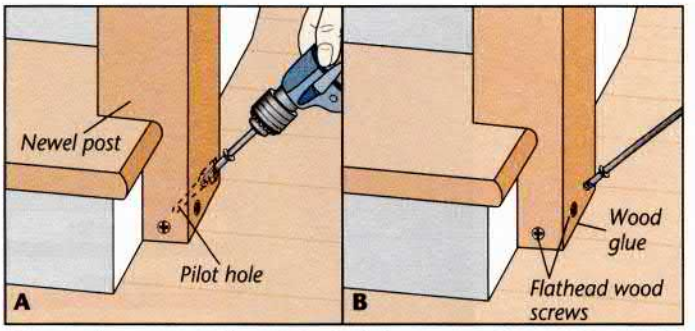


Balusters nailed to treads. Drill an angled pilot hole through the baluster and into the tread; countersink the hole (A). Insert a wood screw and tighten (B). Fill the hole with wood putty, sand smooth when dry, and finish.

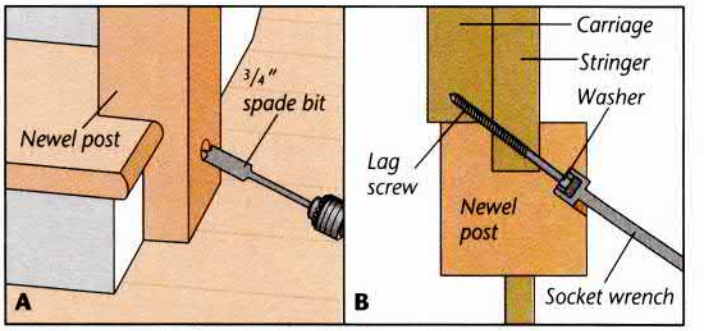


Notch-and-tenon balusters. Pry off the molding with a putty knife or chisel (A). Drill a pilot hole through the tenon into the tread; countersink. Apply epoxy around the notch and tenon. Insert screw and tighten (B). Replace molding.

Two ways to tighten a loose newel post



Glue and screws. Drill angled pilot holes near the base of the newel post through the post into the floor; countersink the holes (A). Apply wood glue between the post and floor; insert flathead wood screws and tighten (B). Fill the holes with wood putty, sand smooth when dry, and finish.



Lag screws and plugs. Use a 3/4-inch spade bit *(page 16)* to drill a 3/4-inch-deep hole into the newel post (A). With a 7/32-inch bit, extend hole into the carriage; then use a 5/16-inch bit to enlarge hole through the newel. Screw in a 5/16- by 4-inch-long lag screw (B). Glue in a dowel plug, sand, and finish as desired.

The Plumbing System

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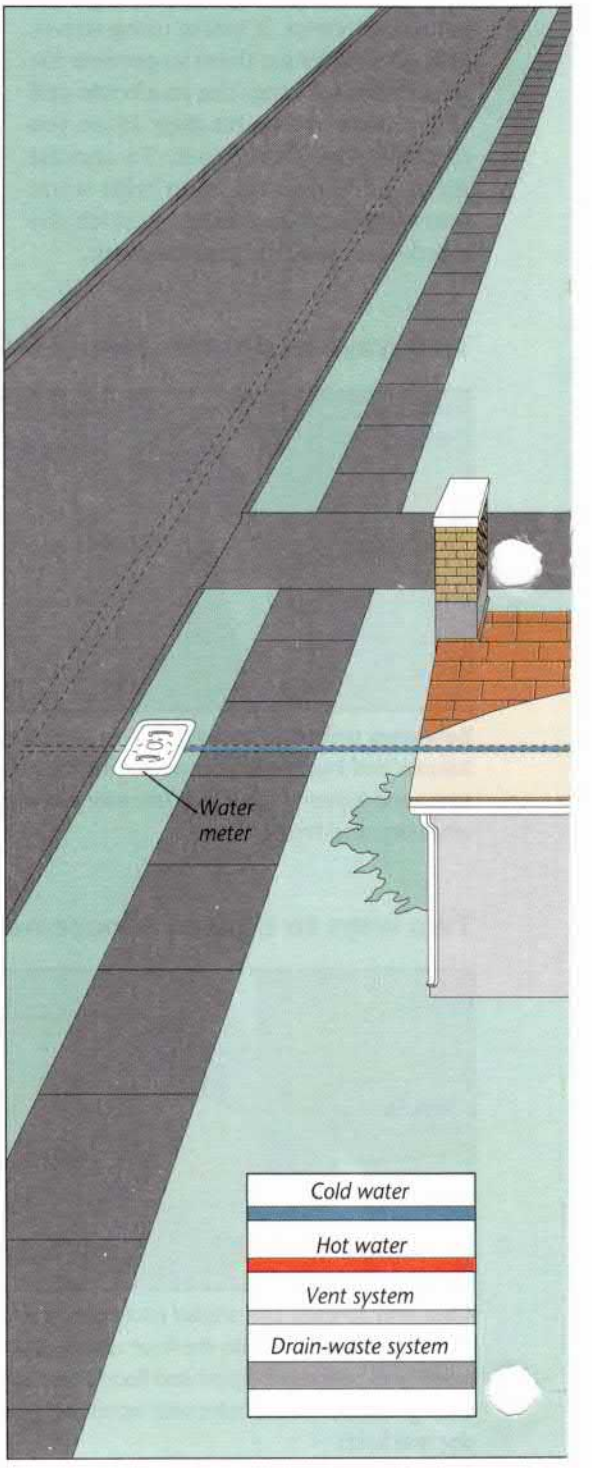
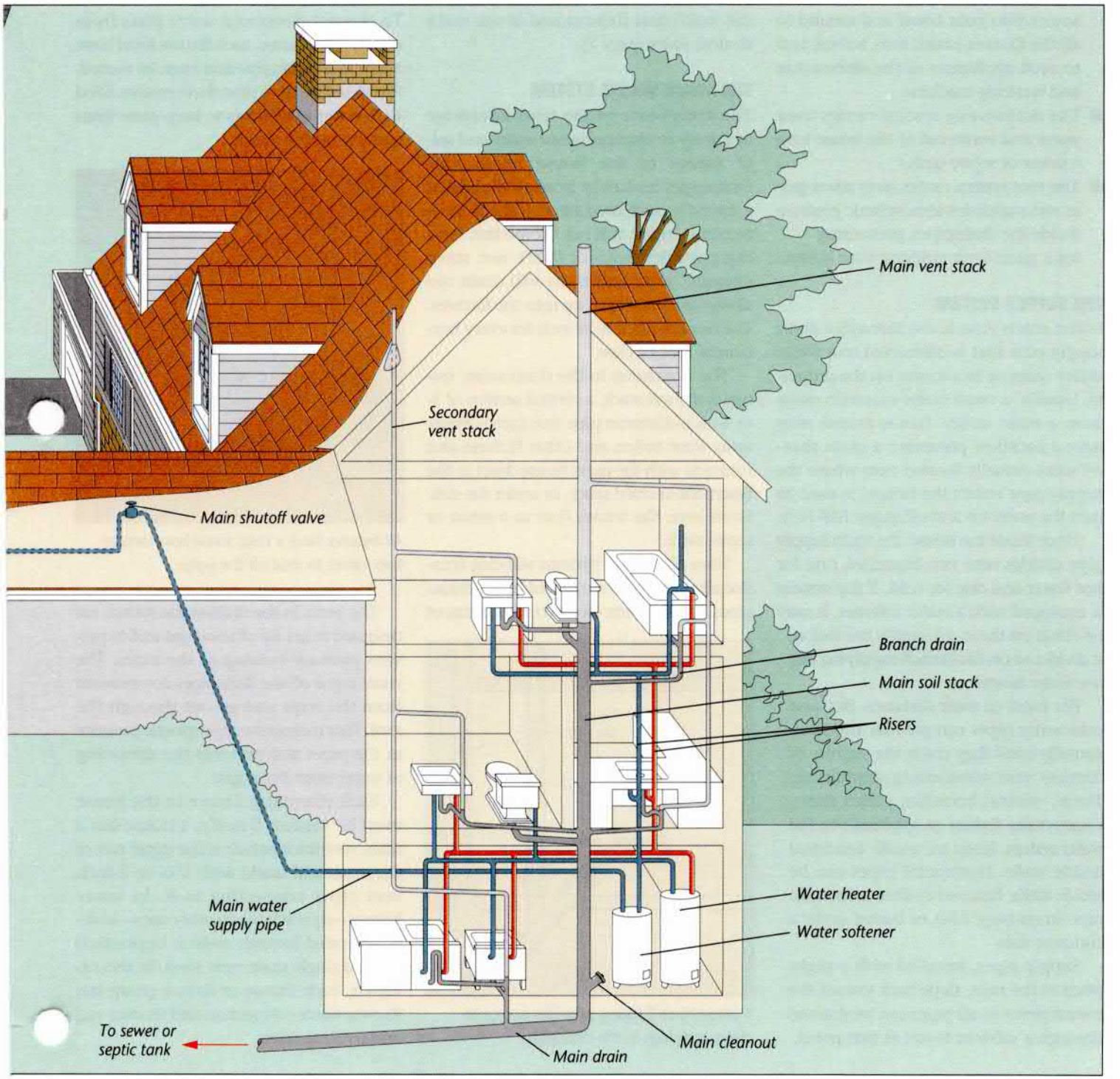


This behind-the-scenes look at a typical home plumbing system shows three separate but interdependent systems: supply, drain-waste, and vent. Hot and cold water flow through the supply pipes; drain-waste pipes carry away used water and waste. The vent system gets rid of sewer gas at each fixture and maintains atmospheric pressure in the drainpipes to keep trap seals intact.



HOW THE SYSTEM WORKS

When you're making plumbing repairs, it helps to understand the plumbing system hidden behind your home's walls and under its floors. In a typical plumbing scenario, three systems are actually at work: supply, drain-waste, and vent.

- The supply system carries pressurized water from a water utility or other source into your house and around to all the fixtures (sinks, tubs, toilets) and to such appliances as the dishwasher and washing machine.
- The drain-waste system carries used water and waste out of the house into a sewer or septic tank.
- The vent system carries away sewer gases and maintains atmospheric pressure inside the drainpipes, preventing toxic gases from entering your home.

THE SUPPLY SYSTEM

Water enters your house through a main supply pipe that is connected to a water utility main or to a source on the property. Usually, a water meter monitors usage from a water utility. Newer homes may have a backflow preventer; a main shutoff valve (usually located near where the supply pipe enters the house) is used to turn the water on and off *(pages 108-109)*.

Once inside the house, the main supply pipe divides into two branches, one for hot water and one for cold. If the system is equipped with a water softener, it may be either on the main supply line before it divides or on the branch supplying just the water heater.

For most of their distance, hot and cold water pipes run parallel and horizontally until they reach the vicinity of fixtures and water-using appliances. There, vertical branches, called risers, connect the fixture or appliance to the water system. Risers are usually concealed inside walls. Horizontal pipes can be inside walls, fastened to floor joists with pipe straps *(page 134)*, or buried under a concrete slab.

Supply pipes, installed with a slight pitch in the runs, slope back toward the lowest point so all pipes can be drained through a valve or faucet at that point.

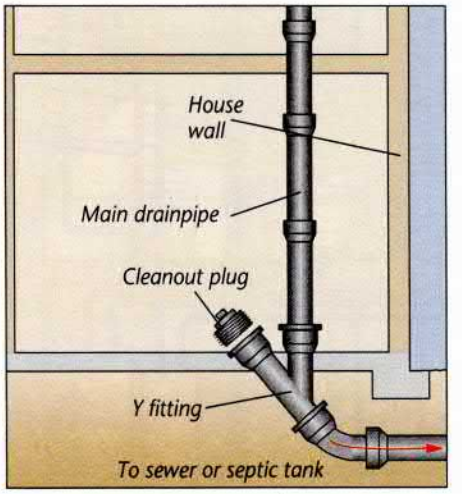
Some fixtures and water-using appliances have their own shutoff valves *(shown at right below)*. These allow you to shut off the water to make repairs without cutting off the water supply for the entire house. To be prepared for an emergency, everyone in the household should learn how to turn off the water supply both at the individual fixtures and at the main shutoff valve *(page 7)*.

THE DRAIN-WASTE SYSTEM

The drain-waste system takes advantage of gravity to channel waste water and solid wastes to the house sewer line. Drainpipes lead away from all fixtures at a carefully calculated slope. If the slope is too steep, water will run off too fast, leaving particles behind; if it's not steep enough, water and waste will drain too slowly and may back up into the fixtures. The normal pitch is 1/4 inch for every horizontal foot of pipe.

The workhorse in the drain-waste system is the soil stack, a vertical section of 3- or 4-inch-diameter pipe that carries waste away from toilets and other fixtures and connects with the main house drain in the basement or crawl space, or under the slab. From here, the wastes flow to a sewer or septic tank.

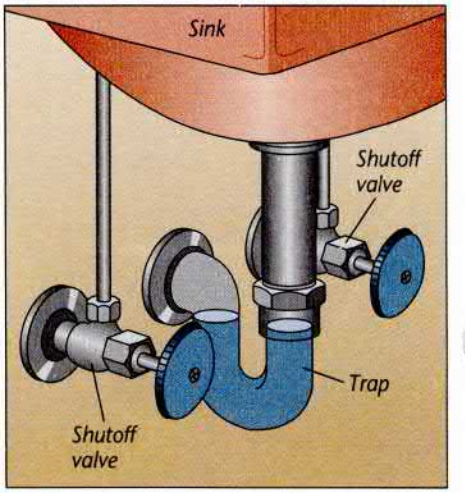
Since all types of systems will clog occasionally, cleanouts are placed in the drainpipes. Ideally, there should be one cleanout in each horizontal section of drainpipe, plus cleanouts in a main house trap, sometimes located outdoors, to give access to sewer or septic tank connections. A cleanout is usually a 45° Y fitting or 90° T fitting, designed for cleaning with a snake.



Y (shown) or T fitting provides access to clean out clogs in the drainpipe.

THE VENT SYSTEM

To prevent dangerous sewer gases from entering the home, each fixture must have a trap in its drainpipe and must be vented. A trap is a bend of pipe that remains filled with water at all times to keep gases from coming up the drain.



All fixtures have a trap; some have one or two valves to shut off the water.

The vents in the drain-waste system are designed to get rid of sewer gas and to prevent pressure buildup in the pipes. The vents come off the drainpipes downstream from the traps and go out through the roof. This maintains atmospheric pressure in the pipes and prevents the siphoning of water from the traps.

Each plumbing fixture in the house must be vented. Usually, a house has a main vent stack (which is the upper part of the main soil stack) with 1 1/2- to 2-inch vent pipes connecting to it. In many homes—especially single-story ones—widely separated fixtures make it impractical to use a single main vent stack. In this situation, each fixture or fixture group has its own waste connection and its own secondary vent stack.

SINK FAUCETS

The first step in fixing a leaking or sluggish faucet is identifying which of the two basic types of faucets you're dealing with. One is a long-standing design—usually with two handles that come to a spongy stop and one spout—called a compression faucet *(see below)*. The other is a comparatively recent type called a washerless faucet. It has either a single lever or knob or two handles that control the flow and mix of hot and cold water by aligning interior openings with the water inlets. Washerless faucets may be one of several types—disc, valve, ball, or cartridge. An example of each is described on pages 113-116. Because models vary with the manufacturer, identical replacement parts are crucial to successful repair.

Directions for disassembling and repairing compression and washerless faucets appear here and on the following pages. When you're taking the faucet apart, douse stubborn connections with penetrating oil. Wrap the jaws of the wrench with electrical tape so you don't mar the visible parts of the fixture as you carry out the repair.

Before starting any faucet repair, plug the sink so small parts can't fall down the drain; then line the sink with a towel to prevent damage from tools or parts that are accidentally dropped. As you disassemble the faucet, line up the pieces in the order that you remove them so you can more easily put them back together.

CAUTION: Before you begin to work on a faucet, turn off the water at the fixture shutoff valves or at the main shutoff valve *(page 7)* and open the faucet to drain the pipes.

Leaking Compression Faucets

If your faucet has separate hot and cold water handles that come to a spongy stop, it's a compression faucet (also called a stem or washer faucet). In this faucet, a rubber seat washer is secured to the stem, which has very coarse threads on the outside. When you turn the handle to shut off the faucet, the stem is screwed down, compressing the washer against the valve seat in the faucet body. The stem is secured by a packing nut, which compresses the packing (twine, a washer, or an O-ring) and prevents water from leaking around the stem.

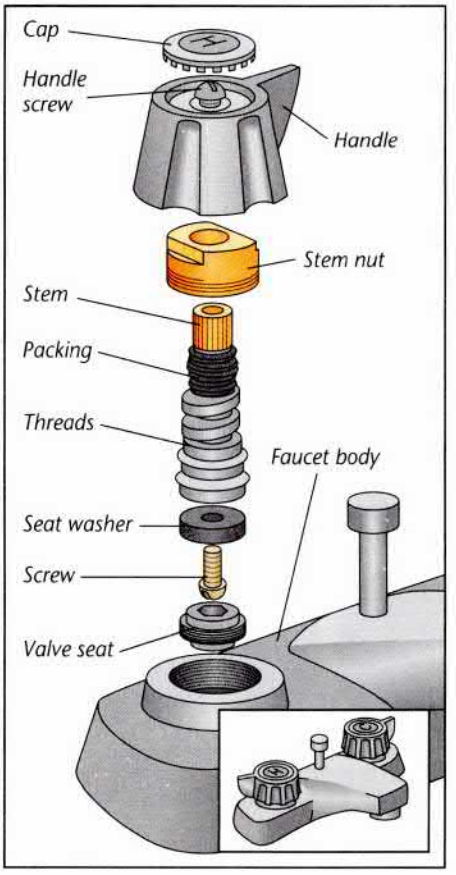
If water leaks around the handle, tighten the packing nut. If that fails, replace the packing *(see page 112)*.

If the faucet leaks from the spout, either a washer is defective or a valve seat is badly worn or corroded. To find out which side needs work, turn off the shutoff valves one at a time to see which one controls water to the faucet. Then you'll need to take off the handle, remove the stem, and either replace the washer or replace or recondition the valve seat *(see page 112)*.

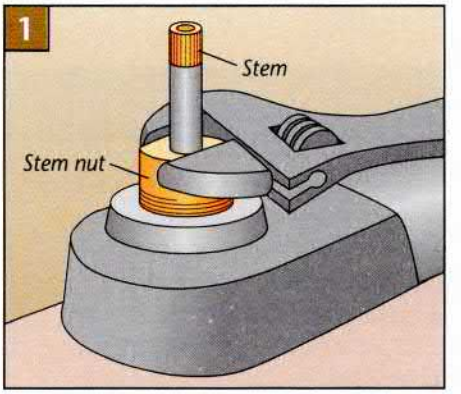
Before you reassemble the faucet, lubricate the stem threads with silicone grease. If the threads are worn or stripped, consider replacing the stem.

Before doing any work, turn off the water at the fixture shutoff valves or at the main shutoff valve *(page 7)*. Open the faucet to drain the pipes.

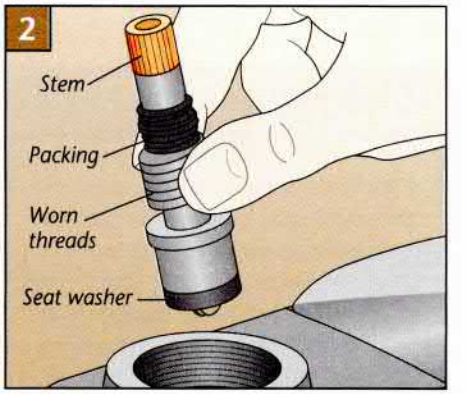
Compression faucet



Taking the faucet apart



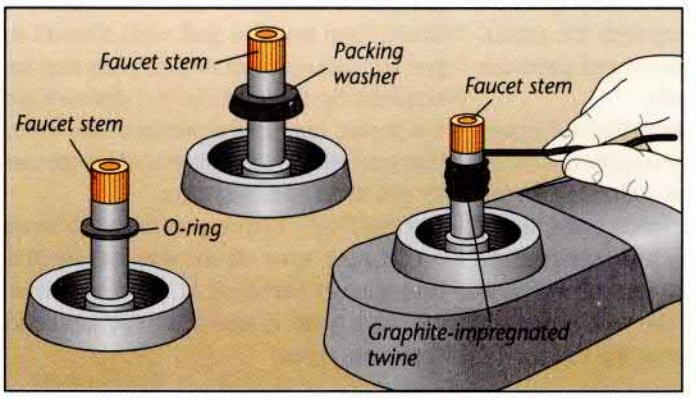
With the handle removed, lift off the stem and packing nuts by turning the nuts counterclockwise with an adjustable wrench or a pair of rib-joint pliers.



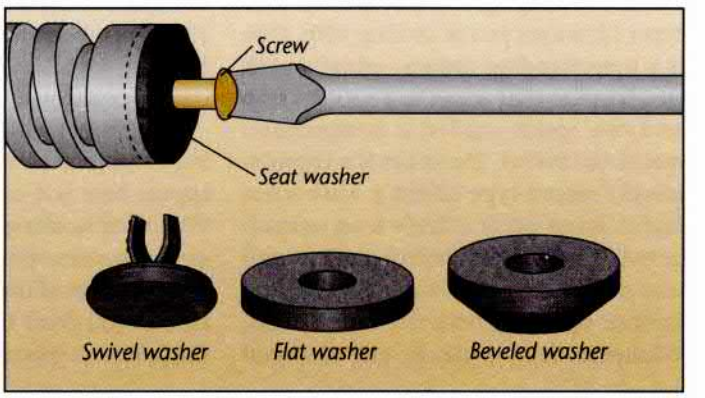
Unscrew the stem; lift it straight out of the faucet body. Examine the threads. If they're damaged or worn, replace the stem; if not, check the packing for wear *(see page 112)*.

...SINK FAUCETS

Replacing the packing and washer

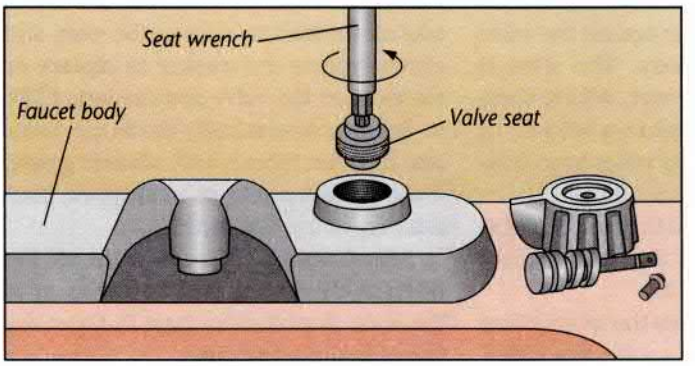


To replace worn packing, either remove the O-ring or packing washer and slide on an exact duplicate, or scrape off the twine and wrap new packing clockwise around the stem.

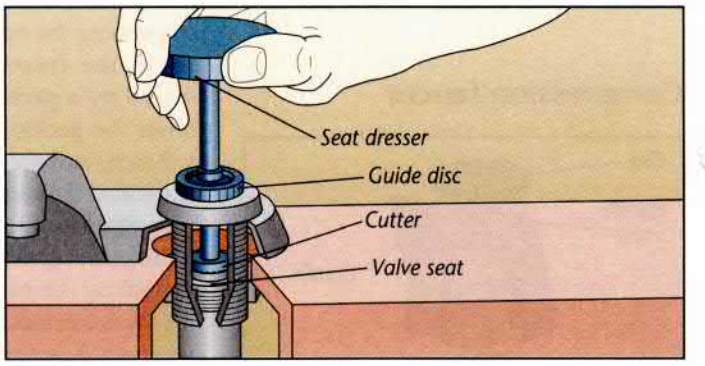


To replace a cracked or worn seat washer, remove the screw and washer; install a duplicate washer. If the threads are too worn to hold a screw, snap in a swivel washer.

Working on the valve seat



To replace a removable valve seat that has become pitted or corroded, insert a seat wrench (page 21) into the valve seat and turn it counterclockwise until the seat lifts out. Coat the threads of the new seat (an exact duplicate) with pipe joint compound and install.



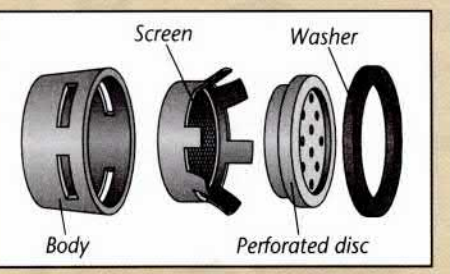
To recondition a nonremovable valve seat, grind down its burrs with a seat dresser, an inexpensive tool you can buy from a plumbing supply dealer. Insert and turn it clockwise once or twice until the seat is smooth; remove metal filings with a damp cloth.

Cleaning Your Faucet Aerator

If the flow from your faucet is sluggish, the trouble may be the faucet aerator. This device, at the tip of most faucet spouts, mixes air and water for a smooth flow. But minerals or dirt particles in the water sometimes build up on the screen and disc, blocking the flow.

If mineral deposits are to blame or if aerator parts are damaged, it's best to replace the aerator. But if dirt is the problem, simply unscrew the aerator from the end of the spout (to loosen stubborn connections, douse them with penetrating oil) and disassemble.

Clean the screen with a brush and soapy water; use a pin or toothpick to open any clogged holes in the disc. Flush all parts with water before reassembling.



Aerator comes apart for easy cleaning.

Leaking Single-handle Disc Faucets

In single-handle disc faucets, the mix and flow of hot and cold water are controlled by two discs (not shown in drawing below) inside the cartridge. Raising the faucet handle lifts the upper disc, controlling the amount of flow; rotating the handle turns the lower disc, controlling the mix. The disc assembly seldom wears out, but if it does you'll need to replace the entire cartridge. Most often, the rubber inlet and outlet seals in the cartridge will prove to be the problem.

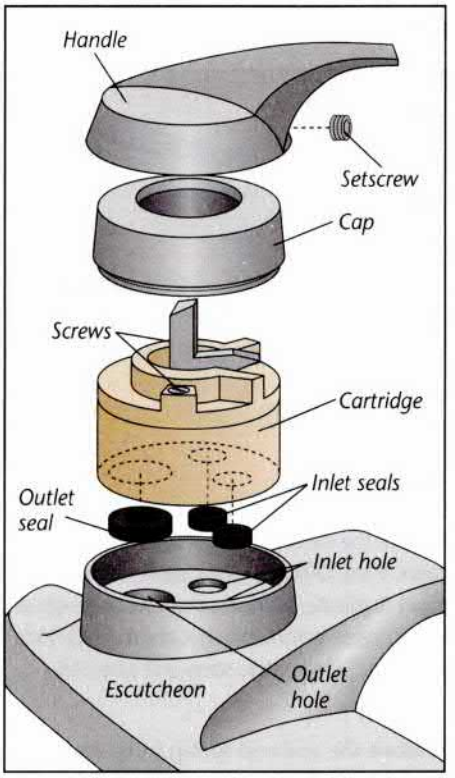
If you have a leak at the base of the faucet, a seal may be worn. Take the faucet apart as shown below; you'll find the set of seals under the cartridge. Replace them with exact duplicates.

If the water flow is sluggish, first check the faucet aerator *(see facing page)*. If that's not the problem, the faucet inlet and outlet holes may be obstructed by sediment buildup; if this is the case, scrape away any deposits.

When reassembling a dismantled faucet, be sure to realign the seals on the bottom of the cartridge with the holes in the faucet body.

Before doing any work, turn off the water at the fixture shutoff valves or the main shutoff valve *(page 7)*.

Disc faucet

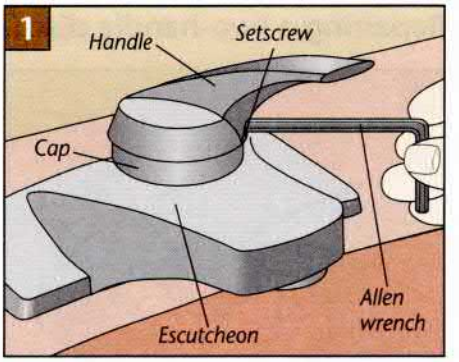


QUICK FIX-UP

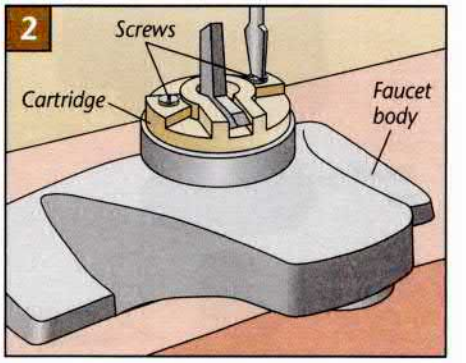
STOPPING FAUCET LEAKS

When water's leaking from around a faucet handle, wrap a rag or dishcloth around the trouble spot to keep it under control until you can make the repair.

Taking the faucet apart

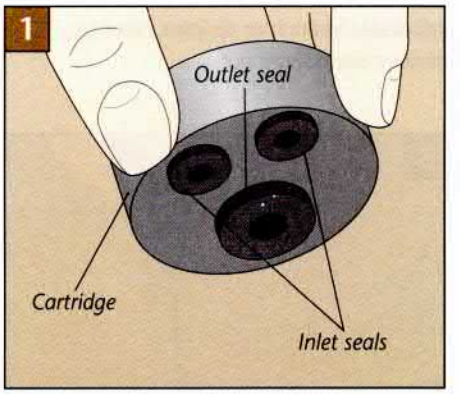


To remove the handle, lift it as high as it can go and loosen—but don't remove—the setscrew with an Allen wrench. Take off the handle and cap.

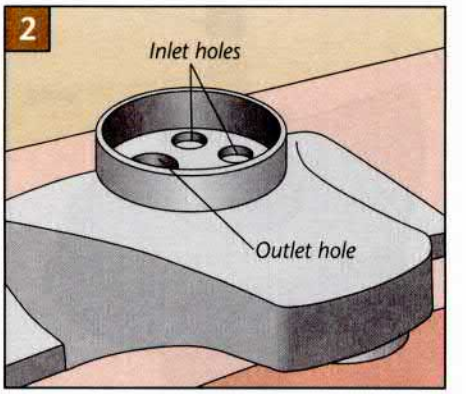


To remove the cartridge, loosen the two screws that fasten it to the faucet body. Then lift the entire cartridge unit straight off the body.

Working on the inlets and outlets



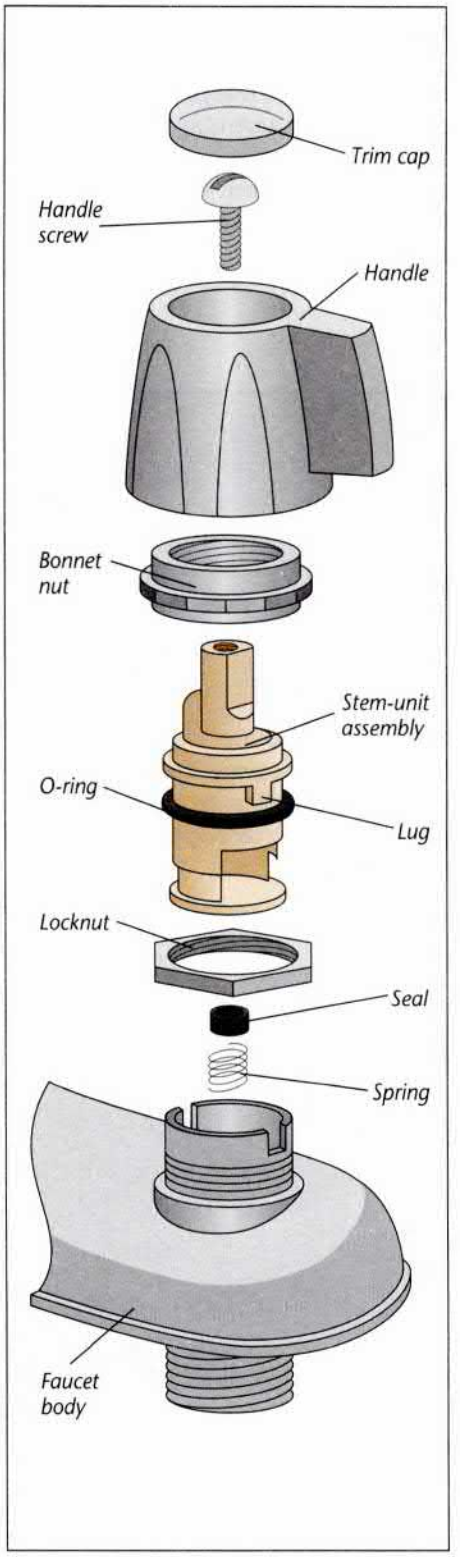
Check the rubber Inlet and outlet seals in the bottom of the cartridge for signs of wear. While you have the faucet taken apart, it's best to remove all the seals and replace them with exact duplicates.



Examine the inlet and outlet holes for sediment buildup. Scrape away any deposits with a blunt knife. Aligning the seals on the cartridge with the holes, replace the cartridge, then the cap and handle.

Leaking Two-handle Disc Faucets

Two-handle disc faucet

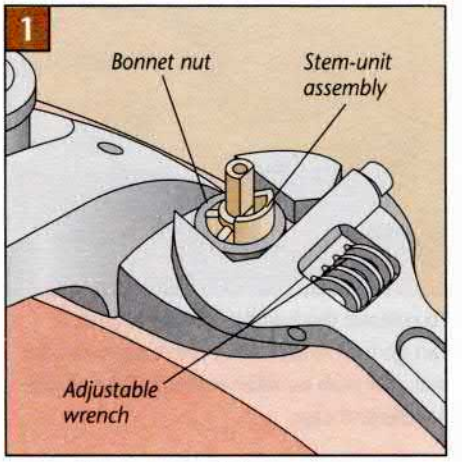


In a washerless faucet such as the model shown at left, openings in two discs inside a sealed cartridge or stem-unit assembly line up with inlet holes to allow the flow of water. While the cartridge in the single-handle model *(page 113)* rarely wears out, the stem-unit assembly on a two-handle model may need to be replaced from time to time. More often, an inlet seal is the weak point. The two-handle disc faucet has a rubber or plastic seal on each side.

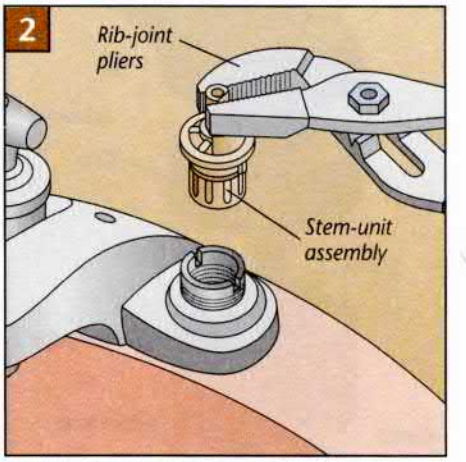
If water flow is sluggish, first check the faucet aerator *(page 112)*. If it is not clogged or blocked, the faucet inlet and outlet holes may be obstructed by sediment buildup; if that is the case, scrape away any deposits.

If the faucet leaks from the handle, the O-ring or stem-unit assembly needs replacing *(Step 2, below)*. If the faucet drips from the spout, the seal and spring probably need replacing *(Step 3, below)*.

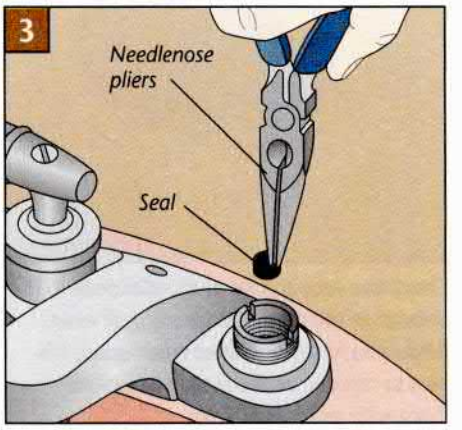
Repairing a two-handle disc faucet



Pop off the trim cap, if there is one, using a blunt knife or screwdriver. Undo the handle screw and pull off the handle. Use an adjustable wrench or rib-joint pliers to remove the bonnet nut.



Pull out the stem-unit assembly with rib-joint pliers. If the O-ring is worn, replace it with an exact duplicate; lubricate the new ring with silicone grease before rolling it on. If the O-rings are sound, replace the stem-unit assembly.



Remove the seal and spring from the faucet body using a pair of needlenose pliers and replace them with parts designed for the same model of faucet. (Take the old parts with you when going to buy replacements.) To reassemble the faucet, put the stem-unit assembly back, making sure to line up the lugs in the assembly with the slots in the base of the faucet.

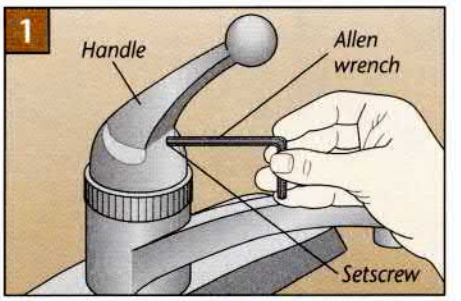
Leaking Ball Faucets

Inside every ball faucet is a slotted metal ball atop two spring-loaded rubber seals. Water flows when openings in the rotating ball align with hot and cold water inlets in the faucet body.

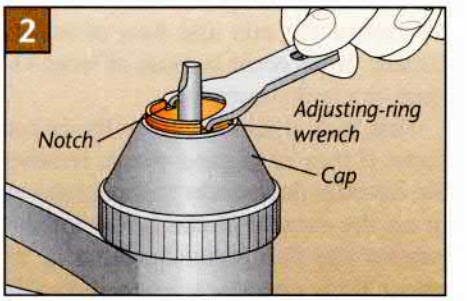
For a leaking handle, leave the water on and tighten the adjusting ring; if the leak persists, turn off the water and replace the cam. For a dripping spout, replace the inlet seals and springs or the ball.

If there are any leaks around the spout sleeve, cure them by replacing the O-rings on the faucet body.

Tightening the adjusting ring

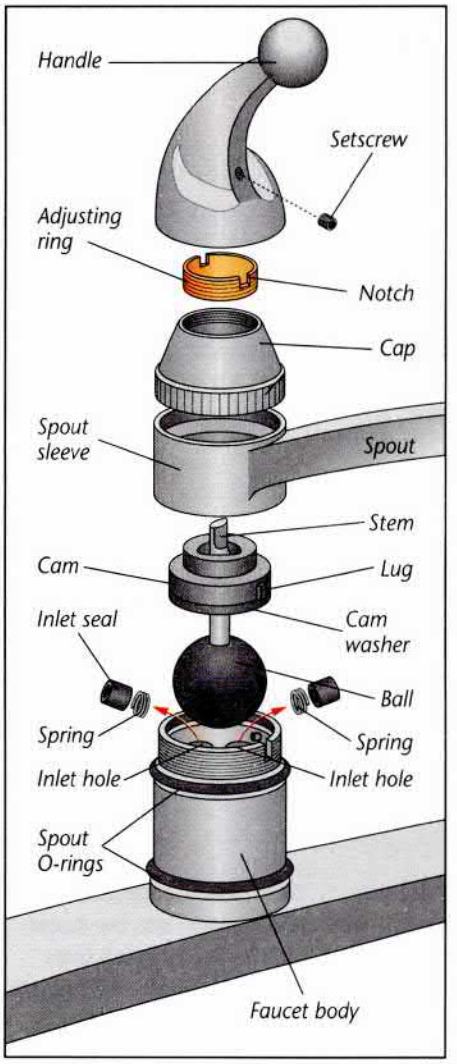


Loosen the setscrew under the handle of the faucet with an Allen wrench and lift the handle off.

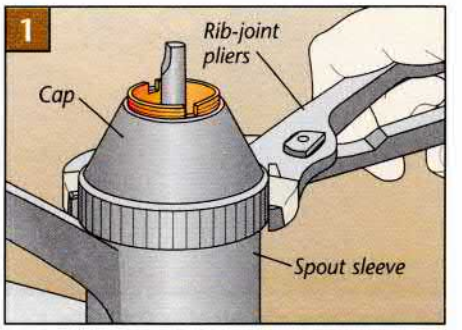


Tighten the adjusting ring in the cap by turning it clockwise with an adjusting-ring wrench as shown or a kitchen knife inserted in the notch.

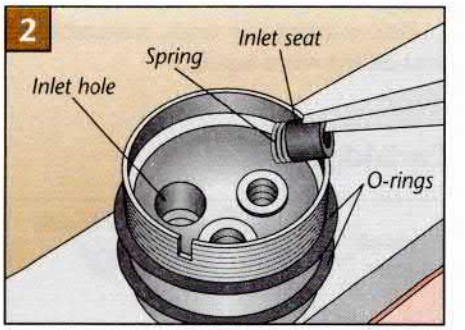
Ball faucet



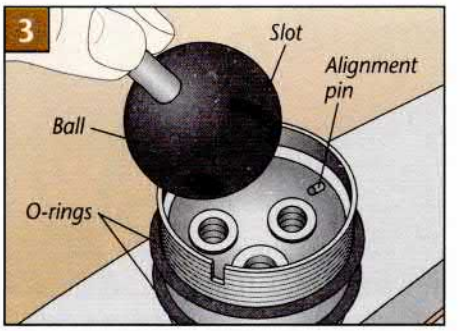
Replacing the faucet parts



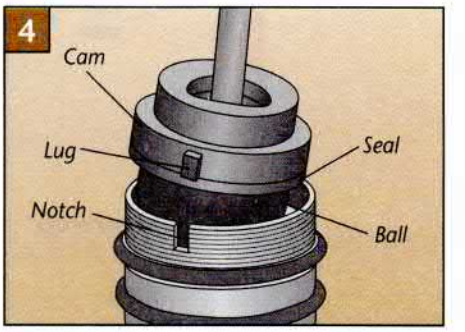
Unscrew the cap using tape-wrapped rib-joint pliers. Lift out the ball and cam; underneath are the inlet seals and springs. Remove the spout sleeve to expose the faucet body.



Lift out the inlet seals and springs, using needlenose pliers. With a penknife, remove any sediment in the holes; replace the inlet seals. Examine the O-rings and replace them if they're worn.



If the old ball is corroded, replace it with a duplicate. When you install the new ball, carefully line up the slot in the ball with the alignment pin in the faucet body.



To replace the cam, fit the lug on the new cam into the notch on the faucet body. Replace the spout sleeve and cap, tighten the adjusting ring, and replace the handle.

Leaking Cartridge Faucets

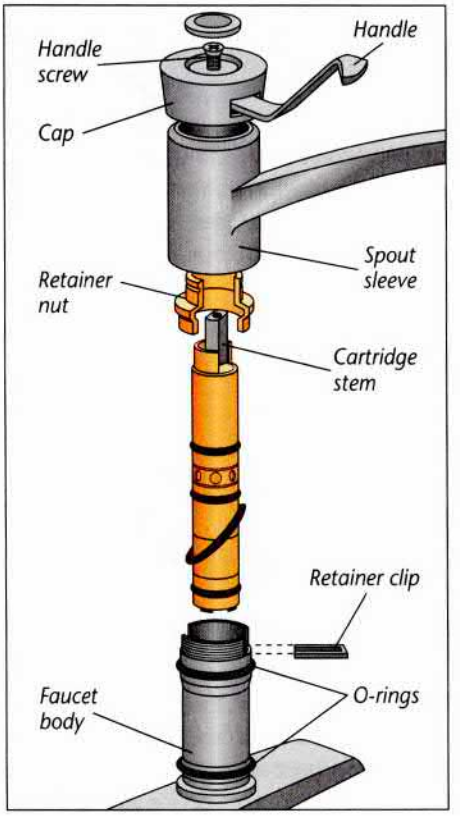
A cartridge faucet has a series of holes in the stem-and-cartridge assembly that align to control the mix and flow of water. Usually, leaks occur because of worn O-rings or a faulty cartridge.

First, look at the O-rings on the faucet body. If they're in good shape, remove the cartridge (look under the spout sleeve or on the outside of the faucet for the retainer clip that holds the cartridge in place). If the cartridge is worn, replace it with an identical one.

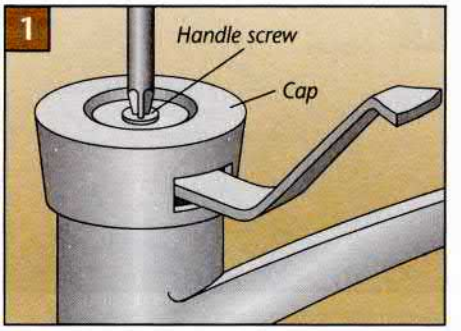
Cartridges vary, so read the manufacturer's instructions before installing a new one. The most common type has a flat side on the stem side that must face front; otherwise, the hot and cold water supply will be reversed. Be sure to fit the retainer clip snugly into its slot.

Before doing any work, remember to shut off the water supply.

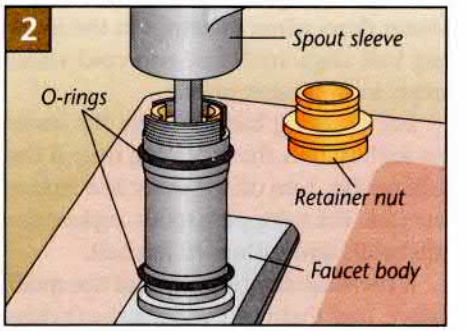
Cartridge faucet



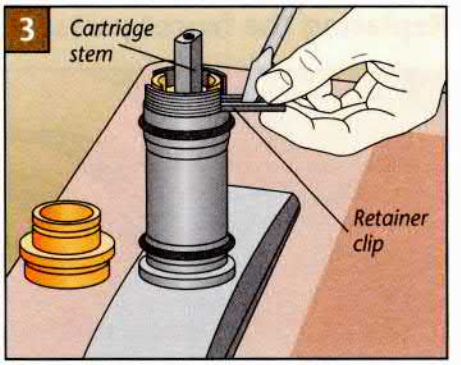
Taking the faucet apart



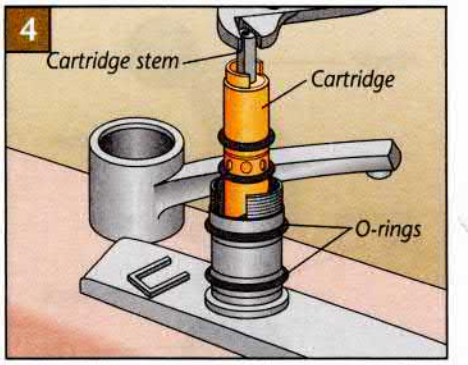
Remove the handle screw with a screwdriver; lift off the cap and handle. Then, remove the retainer nut.



Move the spout sleeve back and forth, and gently pull it off the faucet body. Replace any worn body O-rings.



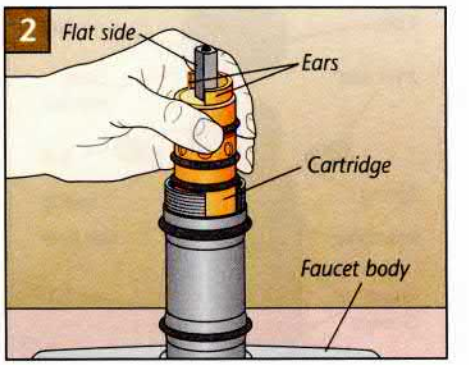
Pull the retainer clip out of its slot in the faucet body using a screwdriver or pliers.



To remove the cartridge, grip the stem with pliers and lift it straight out.

Replacing the cartridge

A defective cartridge may or may not show signs of wear; replace it anyway to get the faucet working again. Take the old cartridge along when you shop for a new one to be sure of getting an exact duplicate.



Push a new cartridge down into the faucet body. If there's a flat side, be sure it faces forward. Reassemble the faucet, making sure to fit the retainer clip snugly into its slot in the body of the faucet.

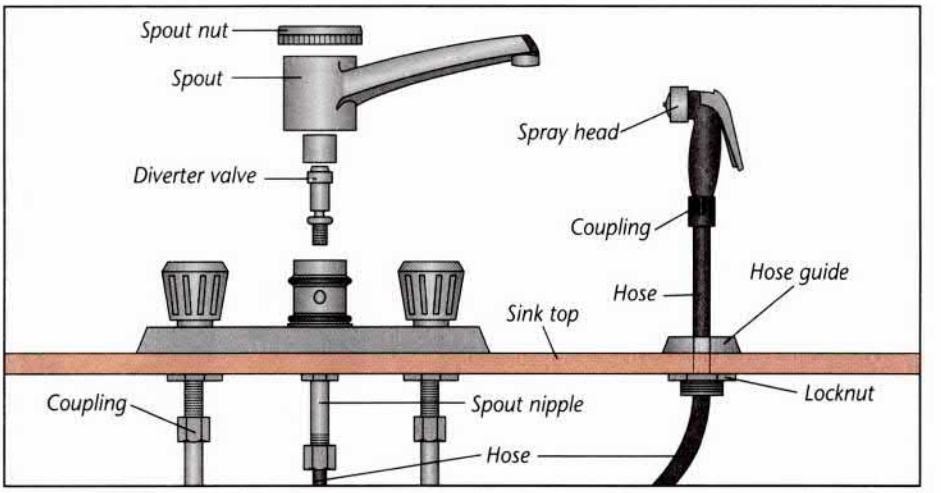
SINK SPRAYS & DIVERTERS

A kitchen sink spray has a spray head attached to a hose, which is connected to a diverter valve in the faucet body. When you squeeze the spray-head handle, the diverter valve reroutes water from the faucet to the spray-head hose. Illustrated is one of several types of diverter valves.

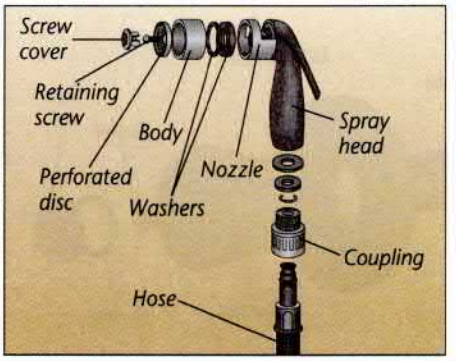
If the flow is sluggish, make sure the hose isn't kinked; then clean the aerator in the spray nozzle. Continued sluggishness may indicate diverter valve problems. You'll have to clean the valve or replace it.

If the spray head leaks, remove it from the hose and replace the washer. For a leak at the faucet end of the hose, tighten the hose coupling. If the hose itself leaks, it's probably cracked; you'll need to replace it.

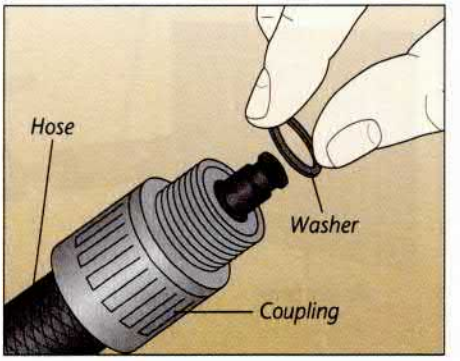
Sink spray assembly



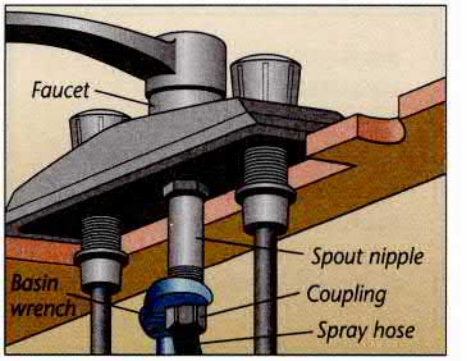
Correcting three sink spray problems



To unclog a spray nozzle, remove the retaining screw and clean the perforated disc with a brush and soapy water; open clogged holes with a pin.



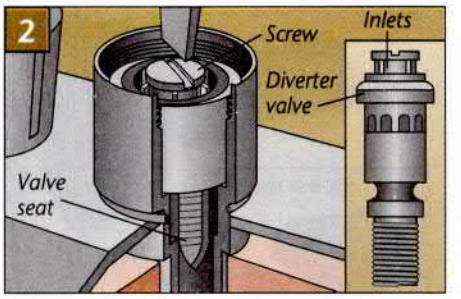
To correct a leaking spray head, turn off the water; unscrew the spray head and replace the hose washer if worn. Also try tightening the coupling.



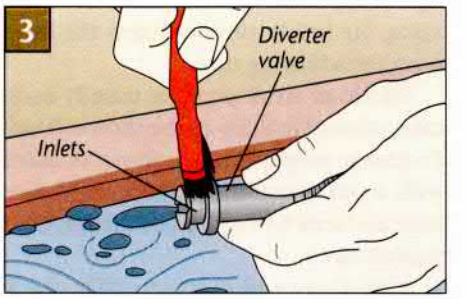
To replace a spray hose, use a basin wrench to unfasten the coupling under the sink; also unfasten the spray-head coupling. Replace the hose with a duplicate.

Cleaning a diverter valve

Unscrew the spout nut to reach the diverter valve in a compression faucet (diverters vary in washerless faucets).



Loosen the screw on the top of the diverter valve just enough to loosen the valve so you can lift it out of the faucet body.



Take the valve apart; clean inlets and surfaces with a brush and soapy water (or lime remover if needed); or replace if defective.

TUB FAUCETS & SHOWER HEADS

Leaking Tub Faucets

Like sink faucets, tub faucets can be compression style or washerless. If you need to repair a leaking tub faucet, refer to the directions for sink faucets on pages 111-116.

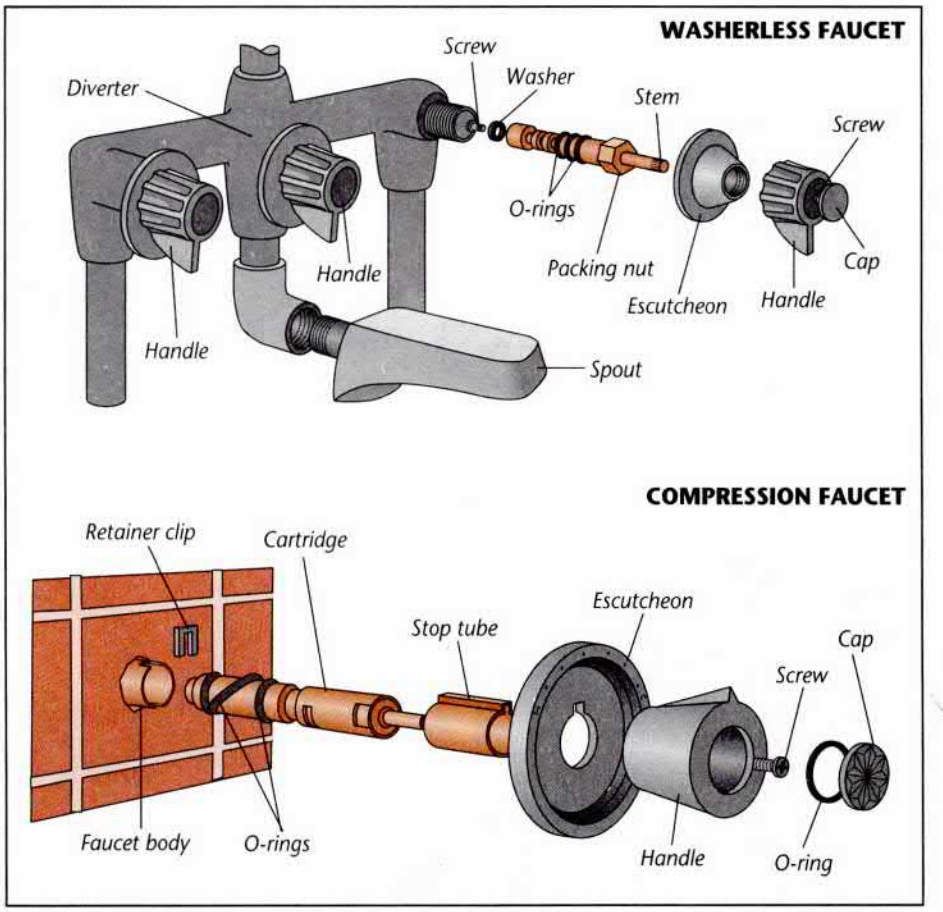
To take apart any tub faucet, pry off the cap, unscrew the handle, and remove the escutcheon. In a compression faucet, you'll see the stem and packing nut. You may need to use a deep-socket wrench *(page 21)* to grip and loosen a recessed packing nut.

The washerless tub faucet shown here is repaired in almost the same way as a cartridge-type sink faucet *(page 116)*. You remove the stop tube and retainer clip to get at the cartridge. Another kind of washerless tub faucet (not shown) is repaired like a ball-type sink faucet *(page 115)*.

PROFESSIONAL TIPS
LOOSENING FROZEN CONNECTIONS

Instead of using a wrench to force nuts and couplings frozen in place, douse the connection with penetrating oil. Wait half an hour; then loosen with a wrench.

Two types of tub faucets



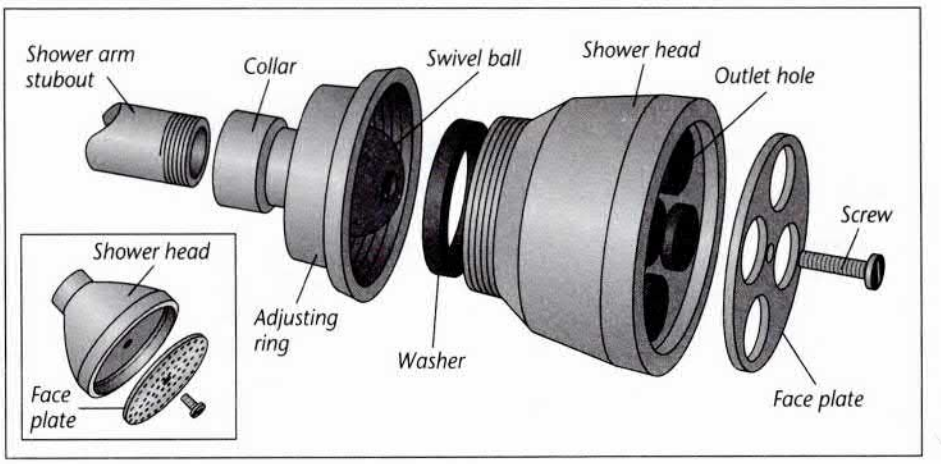
Faulty Shower Heads

If your shower head leaks where it meets the arm, you probably need to replace the washer. To reach it, loosen the collar using tape-wrapped rib-joint pliers to avoid damaging the finish; then unscrew the head from the adjusting ring.

Erratic or weak pressure usually indicates mineral buildup in the shower head. To restore proper flow, clean outlet holes with a pin or unscrew a perforated face plate and soak it overnight in vinegar; then scrub it clean.

If the shower head pivots stiffly, check the washer for wear and tear, and coat the swivel ball with petroleum jelly before reassembling the unit.

Two types of shower heads



POP-UP STOPPERS

As its name implies, a pop-up stopper moves up or down to open or close the drain. The most common problem with this type of faucet is a bad fit between the stopper and the sink or tub.

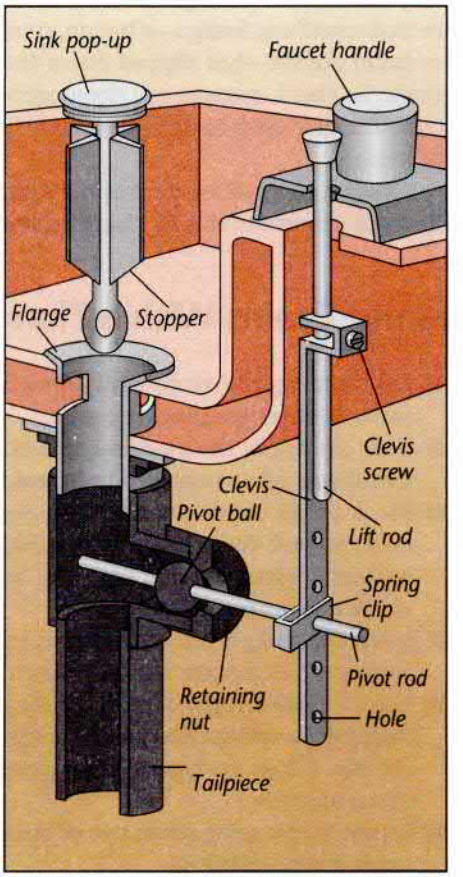
When a stopper doesn't seat properly, you need to remove and inspect it. Some sink stoppers sit atop the pivot rod and simply lift out; others require a slight twist to free them because a slot on the body hooks them to the rod. Still others are attached to the pivot rod.

To remove a tub stopper, pull it out along with the rocker arm. (They should come out readily since the striker spring rests unattached on the rocker arm.)

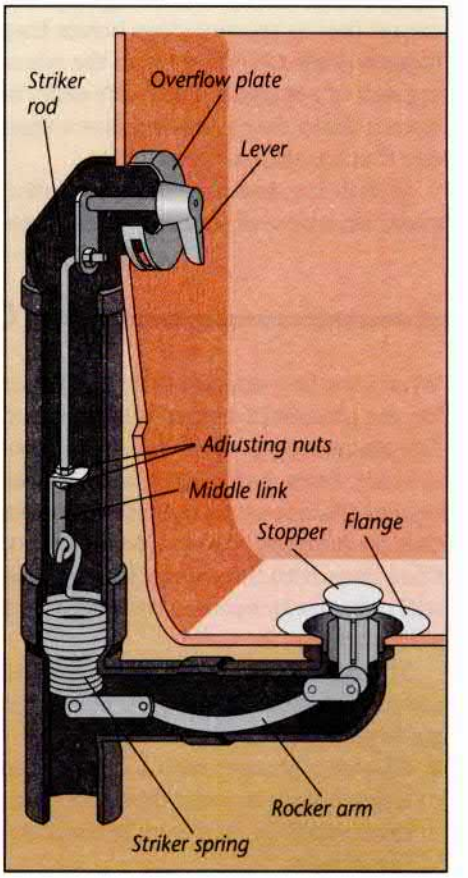
Clean the stopper of hair and debris. If there's a rubber seal, pry it off and check for damage. Slip on a new one if needed. Also make sure the flange is tightly seated and in good shape.

If a sink stopper still doesn't seat properly, adjust the clevis screw, pivot rod, or retaining nut *(see below)*. If a tub stopper doesn't fit after cleaning, remove the overflow plate and pull the entire lever assembly out through the overflow. Loosen the adjusting nuts; slide the middle link up the striker rod. Lower the link for a sluggish drain.

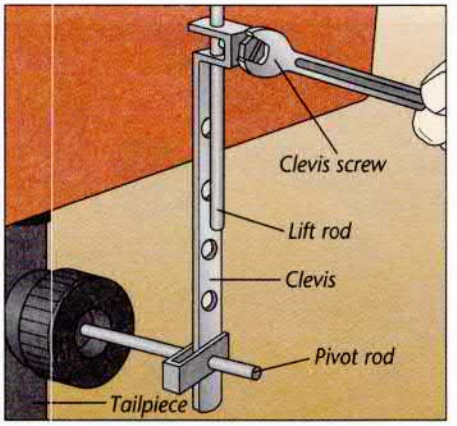
Sink pop-up assembly



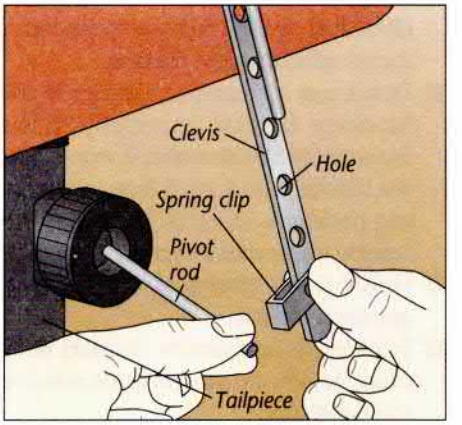
Tub pop-up assembly



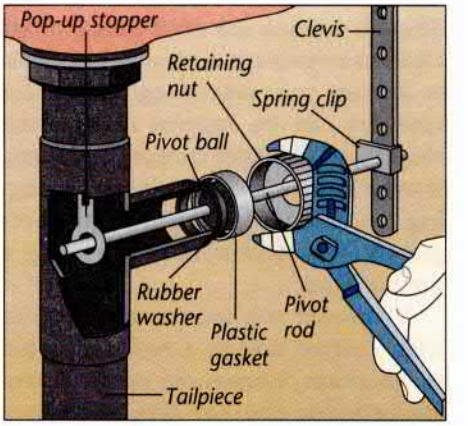
Adjusting a sink pop-up assembly



If a sink pop-up doesn't seat tightly, loosen the clevis screw with a wrench, push the stopper down, and retighten the clevis screw. When the drain is closed, the pivot rod should slope slightly uphill from the clevis to the tailpiece.



If the sink stopper is so tight that it impedes drainage and adjusting the clevis screw doesn't help, reset the pivot rod. Squeeze the spring clip and free the pivot rod. Move the clip up to the next clevis hole; insert the rod.



If water drips from around the pivot ball, use tape-wrapped rib-joint pliers to tighten the retaining nut that holds the ball in place. If the leaking continues, replace the gasket or washer (or both) inside the pivot-ball-and-rod assembly.

SINK DRAINS

A stopped sink drain isn't just an inconvenience; it can be an emergency. It's always best to prevent clogs before they happen *(page 125)*. Be alert to the warning sign of a sluggish drain—it's easier to open a drain that's slowing down than one that has stopped completely.

When it's too late for preventive medicine, a dose of scalding water—especially effective against grease buildup—may be treatment enough. If not, it could be that something foreign—a button, coin, or small utensil—has slipped down the drain. To check, remove and thoroughly clean the sink's pop-up stopper *(page 119)* or strainer.

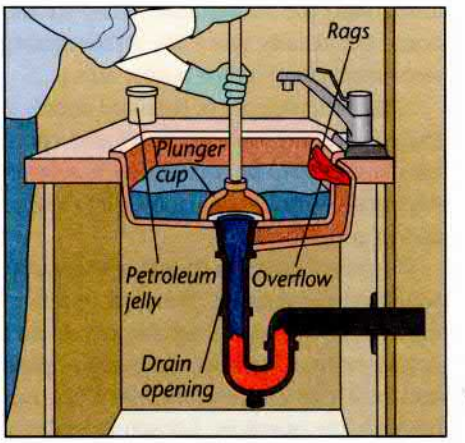
Often, a clog will be close to the sink. You can determine this by checking the other drains in your home. If more than one won't clear, something might be stuck in the main drain *(pages 124-125)*. Otherwise, you're probably dealing with a clog in the sink trap or drainpipe. The most effective way to clear a clog is with a snake *(facing page)*. You can try using a plunger *(below)* or, in some situations, a chemical drain cleaner first.

Clearing Drains With a Plunger

What's the first reaction to a clog? Reach for the plumber's helper—the plunger. The plunger is a good drain clearing tool in many cases, but it often fails to work because it's incorrectly used. Don't expect that by pumping up and down two or three times with the plunger that the clog will necessarily become dislodged and whoosh down the drain.

Though no great expertise is needed to use this simple tool, here are a few tips to guide you:

- Choose a plunger with a suction cup large enough to cover the drain opening completely, as shown in the drawing at right.
- Fill the clogged fixture with enough water to cover the plunger cup.
- Coat the rim of the plunger cup with petroleum jelly to ensure a tight seal.
- Block off all other outlets (the overflow, second drain in a double sink, adjacent fixtures) with wet rags to create a vacuum.
- Insert the plunger into the water at an angle so no air remains trapped under it.
- Use 15 to 20 forceful strokes, holding the plunger upright and pumping vigorously. (Clogs are typically dislodged on an upstroke.)
- Repeat the plunging action two or three times before giving up.



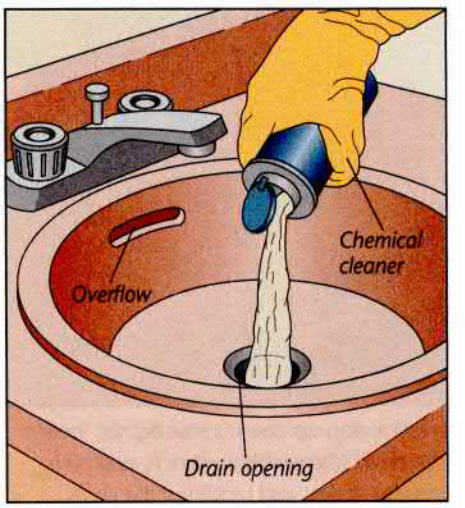
To unclog a sink, pump the plunger vigorously up and down.

Using Chemical Drain Cleaners

Though routine use of chemical drain cleaners to prevent clogs may eventually damage your pipes *(page 125)*, these cleaners can be helpful in opening clogged drains under certain conditions. If water is draining somewhat but plunging has failed to open the drain completely, you may want to try using a drain cleaner.

Whenever you use chemicals, do so with caution and in a well-ventilated room. Drain cleaners can produce dangerous fumes and burn skin on contact, even when mixed with water. Be sure to take these precautions:

- Never use a plunger if a chemical cleaner is present in the drain; you risk splashing caustic water on yourself.
- Wear rubber gloves to prevent the chemical from burning your skin. Avoid splashing the cleaner.
- Don't use a chemical cleaner if the blockage is total, especially if the fixture is filled with water. It won't clear the blockage, and you'll face an annoying problem—how to get rid of the caustic water that's become trapped.
- Never use a chemical cleaner in a garbage disposer.
- Read labels and match cleaners with clogs. Alkalis cut grease; acids dissolve soap and hair.
- Never mix chemicals together. Mixing an acid and an alkali cleaner can cause an explosion.
- Don't look down the drain after pouring in a chemical. The solution often boils up and gives off toxic fumes.



Pour in chemical drain cleaner, protecting your hands with rubber gloves. Avoid splashing or breathing the fumes.

Clearing Drains With a Plumber's Snake

Should the plunger and chemical treatment fail, try the snake (also called a drain-and-trap auger). This tool is a very flexible metal coil that you feed through the pipes to reach the clog.

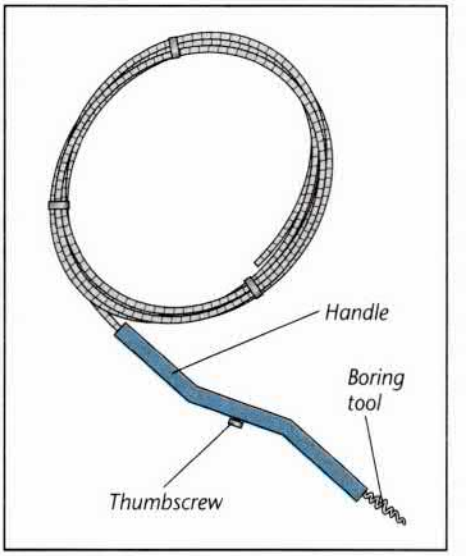
The most effective way to snake out a clog is to remove the trap and snake directly through the drainpipe. If you don't want to remove the trap, you can try snaking through the sink drain opening or the trap cleanout, if any. But be forewarned that if a metal trap is thin or badly corroded, you may punch through it with the snake.

To use the snake, feed it into the drain, trap, or pipe until it stops. If the snake has a movable handle, position it about 6 inches above the opening and tighten the thumbscrew; rotate the handle to break the blockage. If there's no handle, maneuver the cable by simultaneously pushing and twisting until it hits the clog.

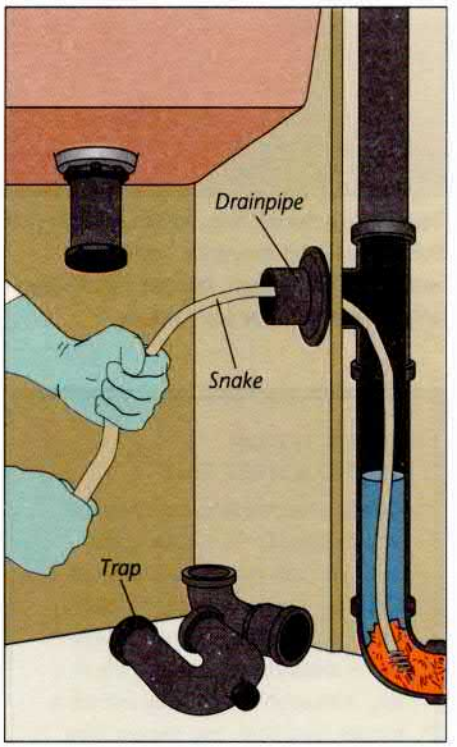
The first time the snake stops, it probably has hit a turn in the piping rather than the clog. Guiding the snake past a sharp turn takes patience and effort. Keep pushing the snake forward and backward, turning it as you do. Once the head of the snake hooks some of the blockage, pull the snake back a short distance to free some material from the clog; then push the rest on through.

If snaking doesn't succeed, the clog is probably too deep in the pipes to reach through the drainpipe. This means you're dealing with a main-drain clog that needs to be attacked through the soil stack, main cleanout, or house trap *(pages 124-125)*.

Plumber's snake

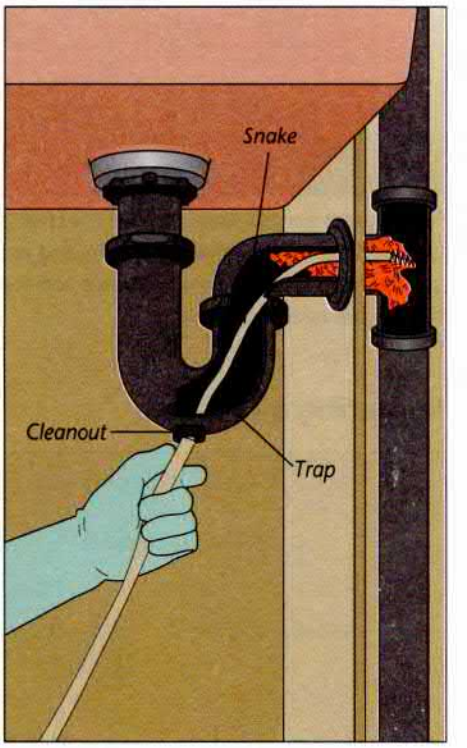


Three ways to use a snake



To snake through the drainpipe, remove the trap (page 122), spilling the contents into a pail. Feed the snake as far as possible behind the wall until it hits the clog.

To snake through the drain, remove the stopper (page 119) or strainer and insert the snake; twist it down through the trap until you reach the clog.



To snake through a trap cleanout, set up a pail, then remove the plug. Direct the snake up toward the drain or toward the wall (as shown) to reach a deeper blockage.

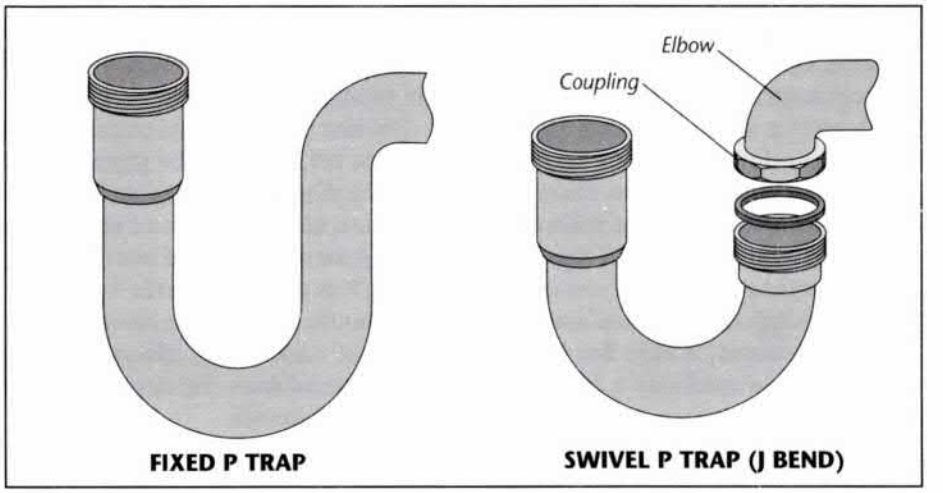
SINK TRAPS

Sink traps often develop leaks or clogs. Corrosion or a loose or stripped coupling can produce leaks. If the drain is clogged and resists all attempts to unclog it *(pages 120-121)*, a mineral buildup inside the trap may well be the cause.

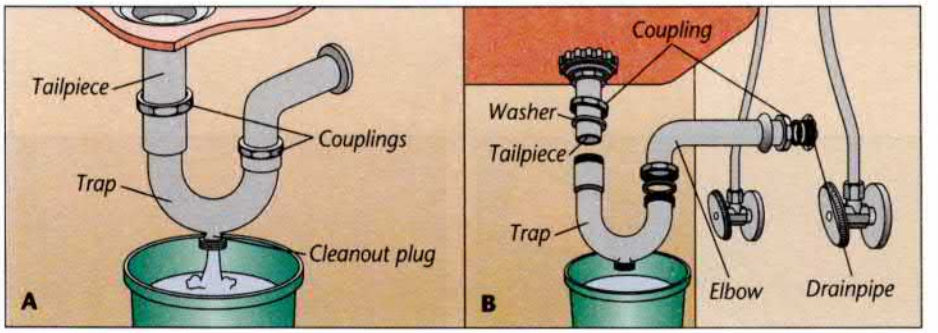
To resolve these problems, you'll need to install a new trap and possibly a new tailpiece. Determine what type of trap you have—swivel or fixed P (the former are more common)—and replace it with an exact duplicate. New units come complete with washers and threaded couplings. Tailpieces are sold separately.

To remove the tailpiece only, see below. Don't force a stubborn unit; remove the trap instead.

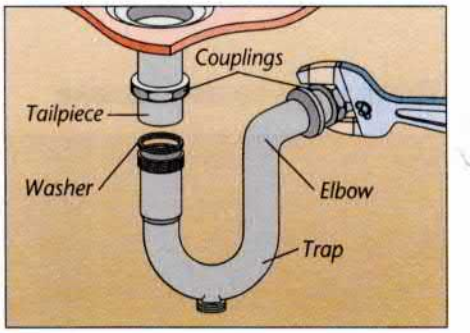
Types of traps



Replacing a trap

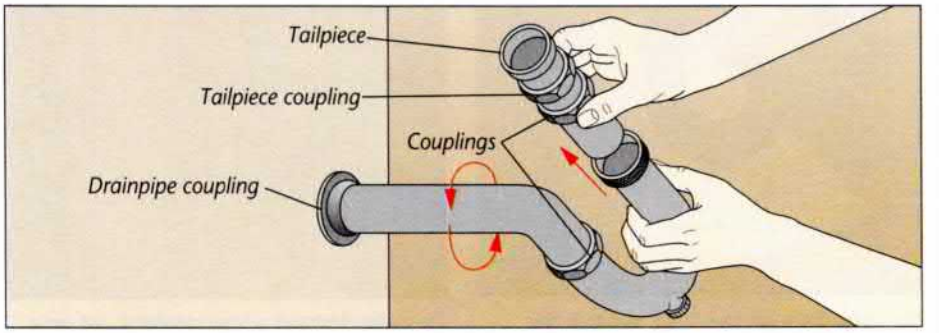


To replace a swivel P trap, remove the cleanout plug (if it has one) to drain water (A). Loosen the couplings at the tailpiece, elbow, and drainpipe with a tape-wrapped pipe wrench. Pull out the old trap. Slide new couplings and washers onto the tailpiece and elbow (B), and tighten the couplings.



To replace a fixed P trap, loosen couplings at the tailpiece and drainpipe with a tape-wrapped pipe wrench, pull out the old trap, and tighten the new one in place.

Replacing a tailpiece



To remove the old tailpiece, unscrew the sink drain and trap couplings; push the tailpiece into the trap. Loosen the drainpipe coupling; swivel the unit and remove the tailpiece. Attach a new one.

QUICK FIX-UP

TAPING A LEAKY TRAP

Here's a helpful stopgap measure you can use to fix a leaking trap until you can install a replacement. First, dry the outside of the trap. Then, wrap electrical tape several times around the area that's leaking. Although the fix may last for a longer time than you expect, you should be sure to install a new trap as quickly as possible.

TUB & SHOWER DRAINS

Plugged Tubs

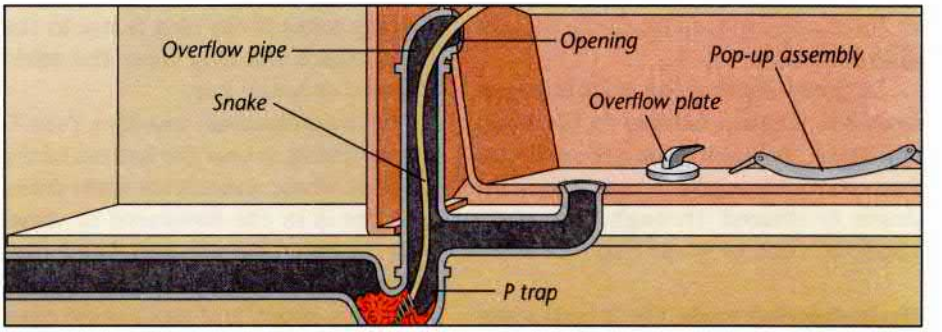
Before trying any drain-clearing methods on a plugged tub, check that the tub's pop-up stopper is opening fully *(page 119)* and is free of hair and debris.

If the stopper isn't the problem, then the drainpipe is probably clogged. If there is some drainage, you can try a plunger or chemical drain cleaner *(page 120)*, but if these fail to do the job, you'll have to clear the trap with a snake.

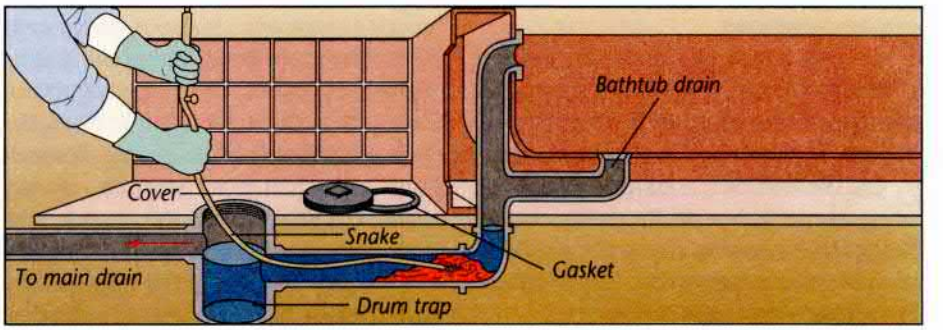
Some tubs have a P trap in the drain, while in other homes the tub may have a drum trap in the floor near the tub instead (it will have a removable metal cover and a rubber gasket).

Using a snake in a tub P trap is much like snaking a sink trap *(page 121)*. If you have a drum trap, first try snaking it clear through the tub overflow. If snaking doesn't work, bail out all of the standing water in the tub. Then, using an adjustable wrench, unscrew the trap cover slowly. Have rags ready for any water that wells up. Remove the cover; bail out and clean the trap. If, after this, water does not well up, snake toward the tub; if water does well up, snake toward the main drain. If you can't reach the clog from the trap, it's probably deeper in the main drain *(pages 124-125)*.

Unclogging two types of tub drains



To unclog a tub P trap, remove the overflow plate and pull out the pop-up assembly, including the rocker arm and spring. Feed the snake down the overflow pipe and maneuver it toward the clog.



To unclog a tub drum trap, bail all water out of the tub and slowly unscrew the trap cover to control any water that wells up. Clean out the trap. If it's still clogged, snake toward the tub, as shown, or toward the main drain.

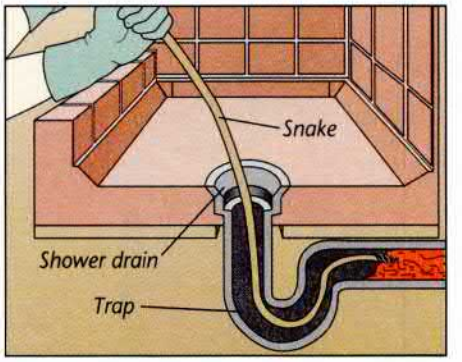
Plugged Showers

Though it may be difficult to unclog a shower drain with a plunger, it's worth a try. If that doesn't work, maneuver a snake down the drain opening into the trap.

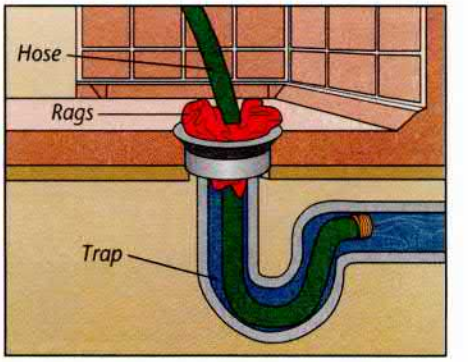
As a last resort, you can use a garden hose. Attach the hose to an outdoor faucet or to an indoor faucet with a threaded adapter. Push the hose deep into the drain and pack rags into the opening. Turning the water on in short, hard bursts should open the drain.

CAUTION: Never leave a hose in any drain; if your plumbing system doesn't have a backflow preventer *(page 110)*, a sudden drop in water pressure could send sewage back into the water supply.

Two ways to unclog a shower drain



Unscrew the strainer from the shower drain. Direct the snake down into the trap, maneuvering it to the clog.



Feed a hose deep into the trap; pack rags in the opening. Turn the water alternately on full force and abruptly off.

MAIN DRAIN & SOIL STACK

If a clog is too deep in the pipes to get at from a fixture *(pages 120-121 and 123)*, the trouble probably lies somewhere in the main drain or soil stack. A blockage in either one can stop up all the fixtures above the clog.

To troubleshoot a clog, trace the pipes from the plugged fixtures to the main soil stack. You can clear the soil stack from above through the vent. The main drain is cleared through the main cleanout, vent, or house trap.

Drain-clearing tools. You'll need a special 50- to 75-foot-long snake—hand-operated or powered—to work on a vent stack. You can rent either tool; if you choose to go with a power snake, use caution and work with a partner—this tool can be dangerous.

Instead of using a snake on a main cleanout or house trap, you can use a garden hose with rags stuffed around it or a balloon bag attached to a hose nozzle.

CAUTION: Exercise extreme care when using a hose; you're dealing with sewage. Never leave a hose in any drain; a sudden drop in water pressure could back-siphon sewage into the water supply.

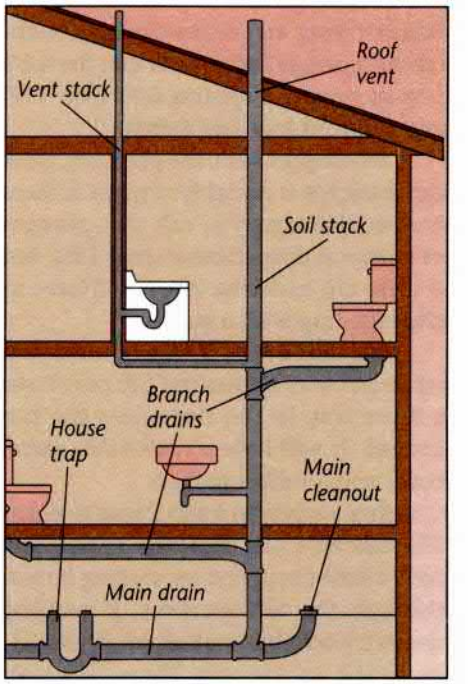
Clearing the soil stack and main drain. First try clearing the stack by feeding a plumber's snake in through the roof vent. (Be especially careful on a steep or slippery roof.) If the clog is not in the stack, attack the clog from the main cleanout or house trap.

The main cleanout, usually a Y- or T-shaped fitting, is near the bottom of the soil stack where it meets the main drain. Look for it in the basement or crawl space, or on an outside wall. Use a pipe wrench to remove the cleanout plug. Have pails, mops, and rags handy; open the plug slowly to control the flow of waste and not release a flood.

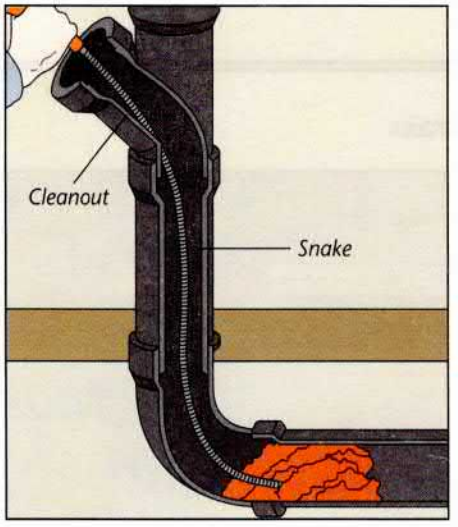
If using a snake, hose, or balloon bag doesn't break up the clog, try the house trap. The house trap—if there is one—has two adjacent cleanout plugs near where the main drain leaves the house. (On newer houses, the house trap is not U-shaped as shown at right. Instead, the main drain is unbent below the cleanout plugs.) With a pipe wrench, slowly loosen the plug nearest the outside sewer line. Probe with a snake, but be ready to withdraw it and cap the trap quickly when water flows. When it subsides, reopen the trap and clean it out from both ends with a wire brush.

After clearing any clog, always flush the pipes thoroughly from upstream in the system, using plenty of clean water.

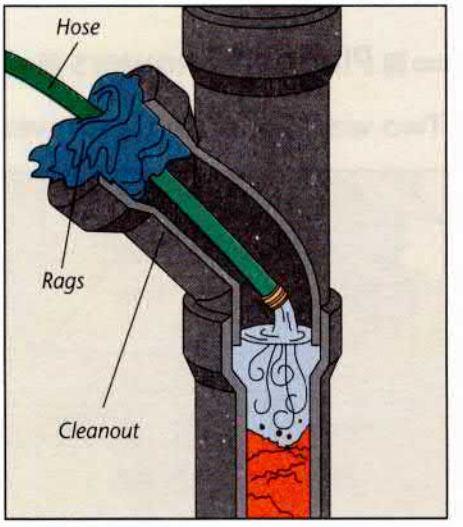
The drain-waste system



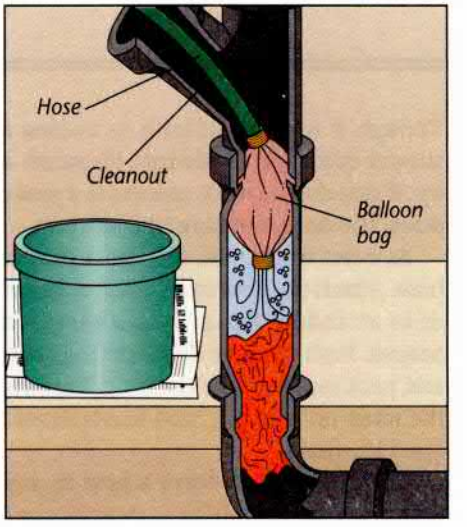
Drain-clearing tools



A snake can probe and maneuver around pipe bends to break up a stubborn clog deep in the pipes.

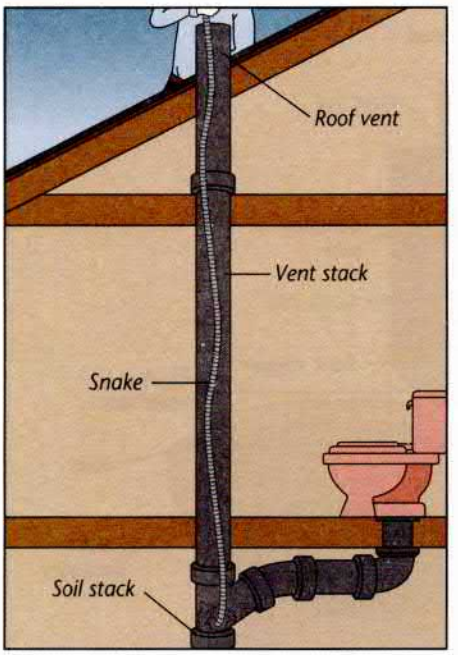


With a rag-packed garden hose, apply abrupt water pressure to force out a deep clog. Use this technique with caution.

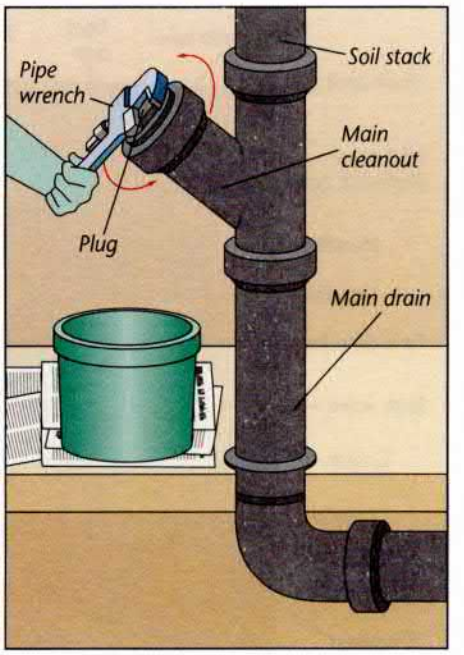


Use a balloon bag to deliver a powerful surge of pressure to break up a clog. Exercise caution when using this technique.

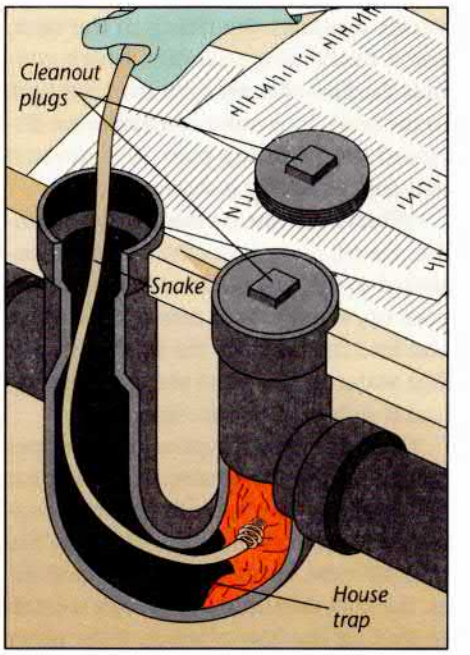
Three ways to clear clogs



Thread a snake through the vent stack to the soil stack, working it from side to side. Exercise caution on the roof.



Remove the main cleanout plug; snake the clog free. Flush, apply pipe joint compound to the plug, and recap.



Use a balloon bag to deliver a powerful surge of pressure to break up a clog. Exercise caution when using this technique.

Preventing Drain Clogs

No plumbing problem is more common or more frustrating than a clogged drain. Kitchen sink drains clog often because of grease buildup that traps food particles. Hair and soap are often at fault in bathroom drains. Drains can usually be cleared easily, but taking some simple precautions will help you avoid stop-ups.

Proper disposal of kitchen waste will keep sink drain clogs to a minimum. Be careful not to pour grease down the kitchen sink. Another villain is coffee grounds—throw them out (they make good compost); don't wash them down.

Be sparing with chemical cleaners, particularly if you have brass, steel, or cast-iron traps and drainpipes; some caustic chemicals can corrode metal pipes. (Plastic drainpipes are more resistant to damage from caustic chemicals.) If used no more than once every few months, cleaners containing sodium hydroxide or sodium nitrate can be safe and effective.

Follow safety precautions (page 120) and package instructions when using drain cleaners. You'll need to let the cleaner sit in the bend of the trap for a while for it to be effective. Be careful not to splash the cleaner around or get any on your skin. Rinse the area thoroughly with clean water when you're finished.

Clean floor drain strainers. Some tubs, showers, and basement floor drains have strainers that are screwed into the drain opening. Remove these strainers with a screwdriver and reach down into the drain with a bent wire to clear out accumulated debris. And be sure to scrub the strainer before putting it back in place.

Clean pop-up stoppers (page 119) in the bathroom sink and tub regularly. Lift out and rinse sink pop-ups once a week.

Every few months, remove the overflow plate on a tub and pull up the pop-up assembly to reach the spring or rocker arm. Remove accumulated hair and rinse thoroughly with warm water.

Keep sewer pipes from the house free of tree roots that may invade them. If roots are a problem in your yard, you may need to call in professionals once a year or so to clear the pipes. They'll use an electric auger to cut out the roots.

Flush drain-waste and vent systems whenever you go up on your roof to clear downspouts or gutters. Run water into vents, giving them a minute or two of full flow until they are free of debris.

TOILETS

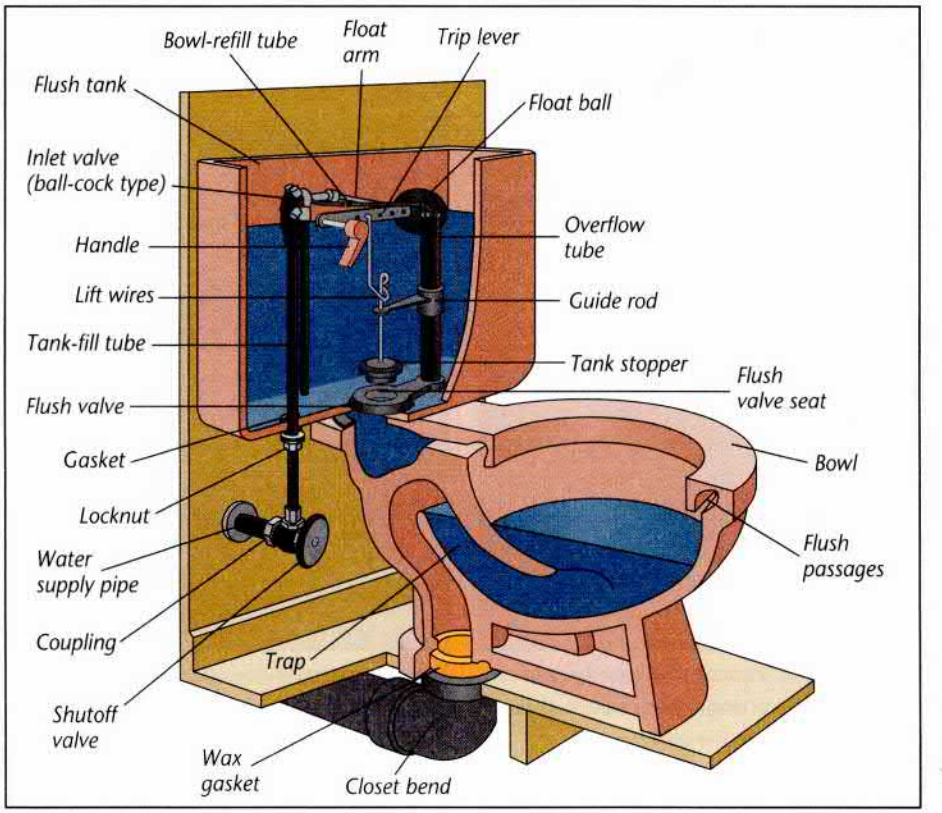
Two assemblies are concealed under the lid of a toilet tank: an inlet-valve assembly, which regulates the filling of the tank, and a flush-valve assembly, which controls the flow of water from the toilet tank to the bowl. Inlet-valve assemblies are discussed on the facing page. A traditional ball-cock assembly is shown at right.

When someone presses the flush handle, the trip lever raises the lift wires connected to the tank stopper. As the stopper goes up, water rushes through the valve seat into the bowl via the flush passages. The water in the bowl yields to gravity and is siphoned out the trap.

Once the tank empties, the stopper drops into the flush valve seat. The float ball trips the inlet valve to let a new supply of water into the tank through the tank-fill tube. As the tank water level rises, the float rises until it gets high enough to shut off the flow of water. If the water fails to shut off, the overflow tube carries water into the bowl to prevent overflow.

On the next five pages are instructions for making toilet repairs. For quick reference, see the chart below.

The parts of a toilet



Troubleshooting a toilet

Problem	Possible Causes	Remedies	Pages
Noisy tank fill	Defective inlet-valve assembly	Oil trip lever, replace faulty washers, or install new inlet-valve assembly	127
	Restricted water supply	Adjust shutoff valve	127
Running toilet	Float arm not rising high enough	Bend float arm down or away from tank wall	128
	Water-filled float ball	Replace ball	128
	Tank stopper not seating properly	Adjust stopper guide rod and lift wires or chain; replace defective stopper	128
	Corroded flush valve seat	Scour valve seat or replace	128, 129
	Cracked overflow tube	Replace tube or install new flush-valve assembly	129
	Inlet valve doesn't shut off	Oil trip lever, replace faulty washers, or install new inlet-valve assembly	127
Clogged toilet	Blockage in drain	Remove blockage with plunger or closet auger	130
Inadequate flush	Faulty linkage between handle and trip lever	Tighten setscrew on handle linkage, or replace handle assembly	131
	Tank stopper closes before tank empties	Adjust stopper guide rod and lift wires or chain	128
	Leak between tank and bowl	Tighten tank bolts or couplings, or replace gasket	131
	Clogged flush passages	Clear obstructions from passages with wire	131
Sweating tank	Condensation	Install tank insulation	131

Noisy Toilets

If you hear a high whine or whistle as the toilet tank fills with water after a flush, the problem may be restricted water flow or a defective inlet-valve assembly.

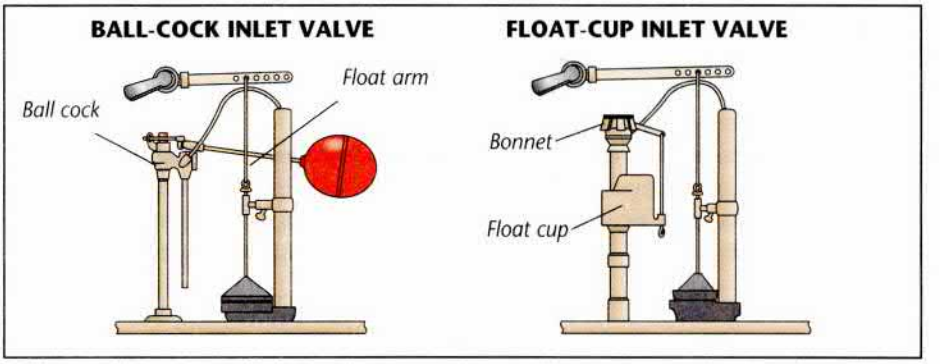
The inlet valve in your toilet tank may be one of several types. Two common varieties—ball-cock and float-cup—are shown at right. (A ball-cock valve is shown in repair sequences.) To avoid any possibility of the valve siphoning water back into the water supply, all new inlet valves must be "anti-siphon"—buy one marked "anti-siphon" or "meets plumbing codes."

To fix a noisy toilet, adjust the shutoff valve first; the problem may be restricted water flow. Still noisy? Oil the trip lever or replace the ball-cock washers. If that doesn't work, replace the entire assembly.

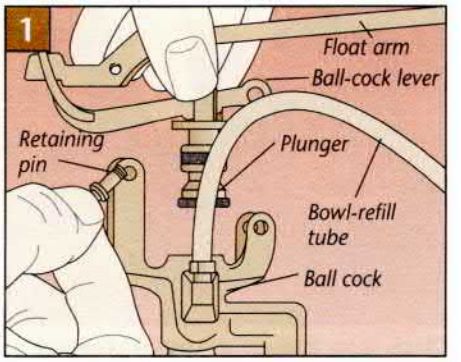
CAUTION: First turn off the water at the fixture shutoff valve; flush to empty the tank and sponge out any water.

PROFESSIONAL TIPS
LOOSENING CONNECTIONS
To avoid dropping a wrench and cracking the fixture, loosen connections with penetrating oil first.

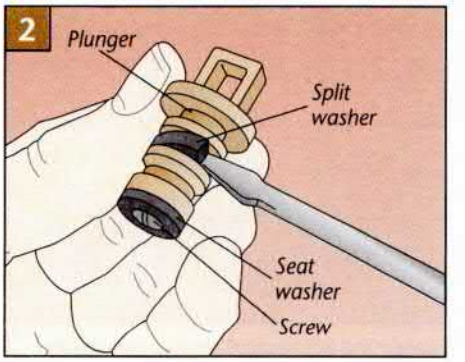
Types of inlet-valve assemblies



Replacing ball-cock washers

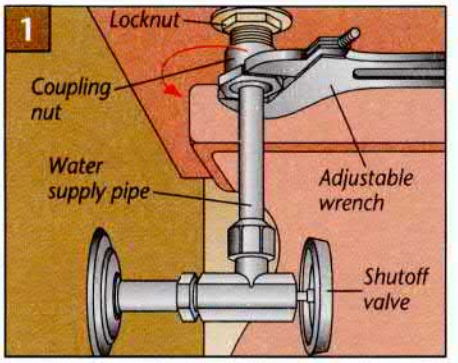


Remove the retaining pins in the ball-cock lever (they may be threaded) and lift out the float arm. Pull the plunger up and out.

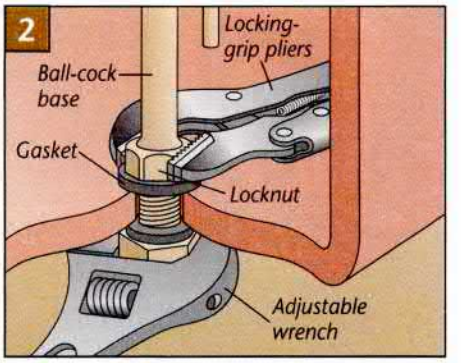


Pry the spilt washer from its groove with a screwdriver and unscrew the seat washer from the plunger's base; replace washers.

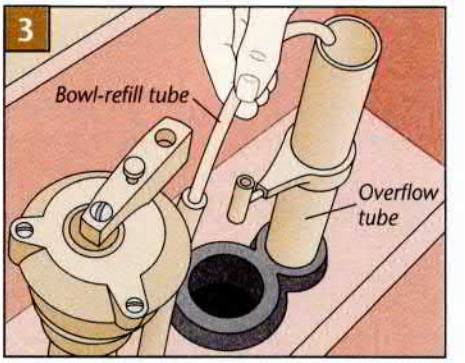
Replacing an inlet-valve assembly



Unfasten the coupling that connects the water supply pipe to the tank. Remove and examine the washer. Replace it if necessary. Remove the float arm.



Using pliers and a wrench, loosen the locknut holding the inlet-valve assembly to the tank. Unclip the refill tube; holding onto the base, remove the inlet-valve assembly.



Install the new anti-siphon inlet-valve assembly according to the manufacturer's instructions (float arm not in place above).

Running Toilets

If water in your toilet tank trickles incessantly, refer to the chart on page 126 for help in diagnosing the cause. If the problem isn't in the inlet-valve assembly *(page 127)*, you may need to adjust or replace the float mechanism or one or more parts of the flush-valve assembly—the overflow tube, valve seat, tank stopper, guide rod, or lift wires. Or you may need to replace the entire assembly.

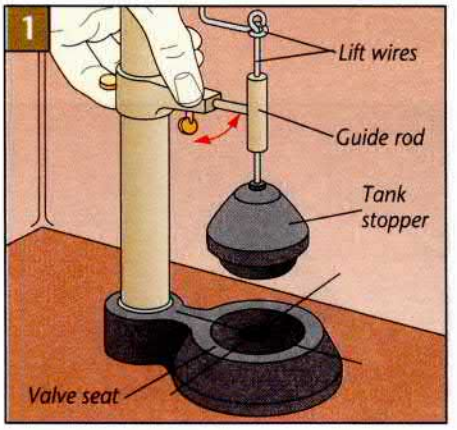
Float mechanism. Bending the float arm downward or away from the back of the toilet tank may stop the water from running. If the float ball is filled with water, it should be replaced.

Flush-valve assembly. A defective or badly fitting valve seat or stopper may cause a running toilet. If the valve seat is rough and pitted, scour it smooth.

If the tank stopper isn't seating properly, try adjusting the guide rod and lift wires or chain. Or replace the stopper. If a metal overflow tube is cracked, replace it. If the toilet is still running, replace the entire flush-valve assembly (you'll have to disconnect the tank from the bowl first).

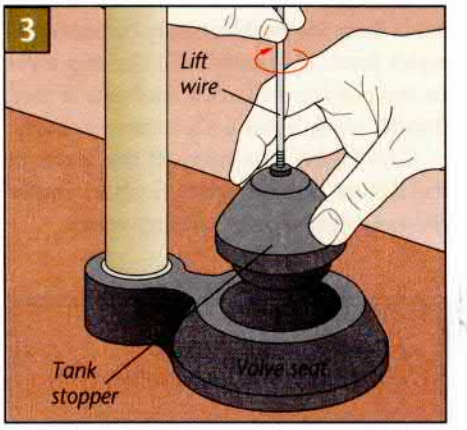
CAUTION: Turn off the water at the fixture shutoff valve; flush the toilet to empty the tank and sponge out water.

Working on the stopper and valve seat



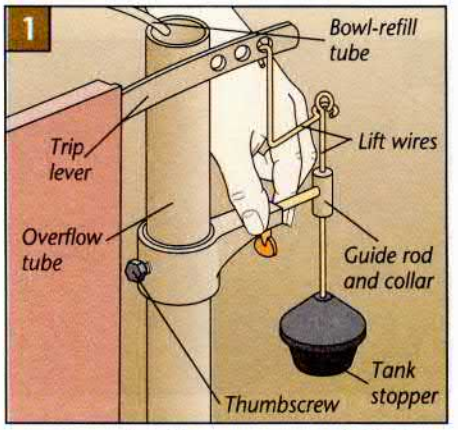
Loosen the adjustment screws and realign the guide arm and rod or bend the lift wires if the stopper doesn't seat properly.

Gently scour a rough and pitted valve seat and then go over it with fine steel wool to smooth the surfaces.

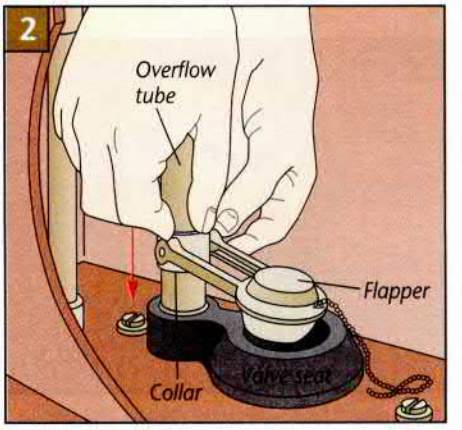


To replace a worn-out tank stopper with a duplicate, unscrew it from the lift wire and screw on a new one.

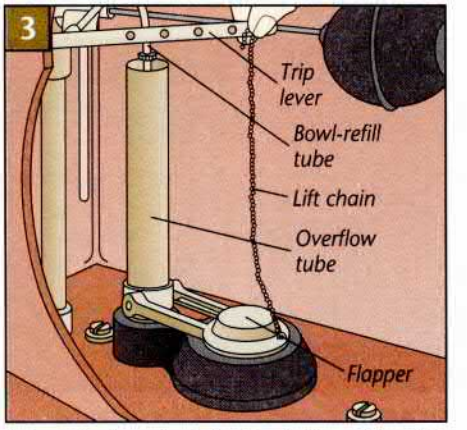
Installing a flapper stopper



To remove the old stopper, unhook the lift wires and loosen the screw on the guide arm. Lift off the guide rod and stopper.

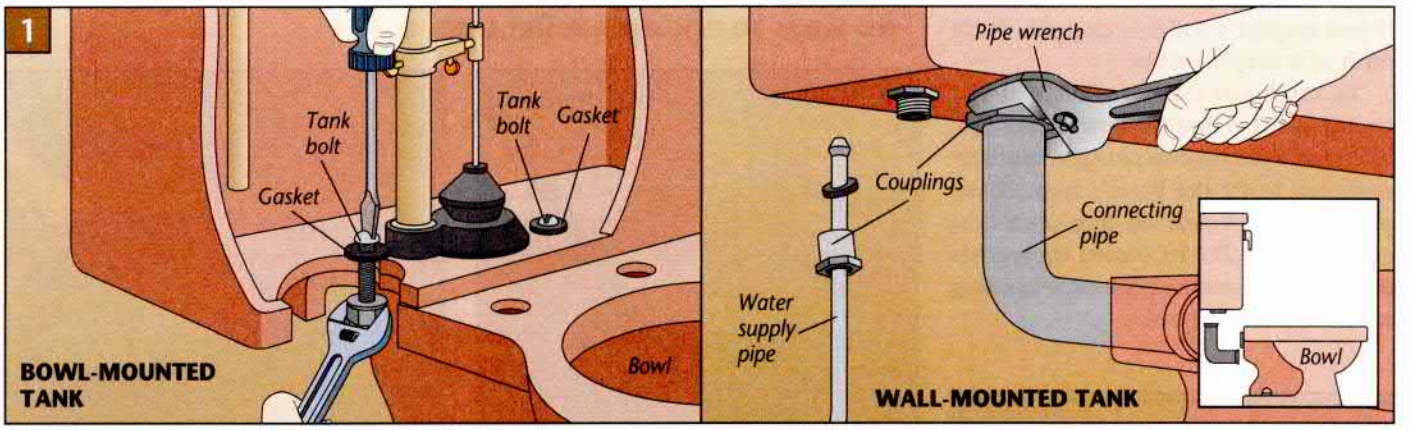


To Install the flapper, slide its collar to the base of the overflow tube. Position the flapper over the valve seat.

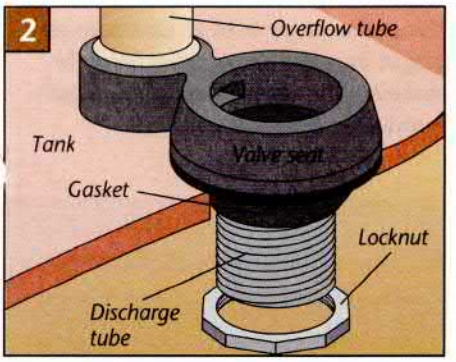


Adjust the length of the lift chain and hook it on the tip of the trip lever, leaving about 1/2 inch of slack.

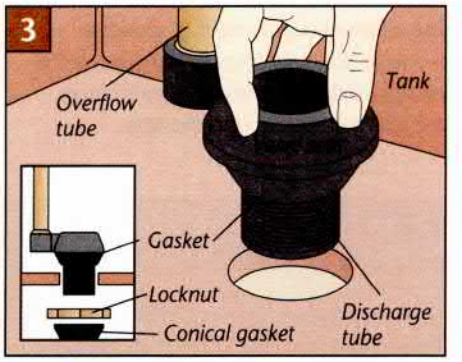
Replacing the flush-valve assembly



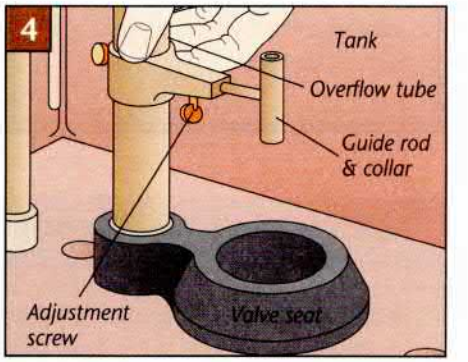
After turning off the water supply and draining the tank, disconnect the water supply pipe. Then, for a bowl-mounted tank *(left)*, remove the tank bolts and gaskets; lift off the tank. For a wall-mounted tank *(right)*, loosen the pipe couplings and remove the connecting pipe.



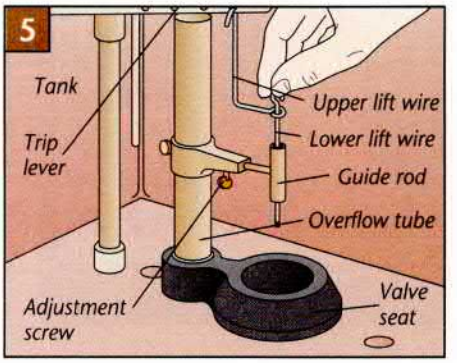
Unscrew the locknut under the tank after removing the conical gasket. Remove the lift wires, guide rod, and stopper; lift out the valve seat and overflow tube.



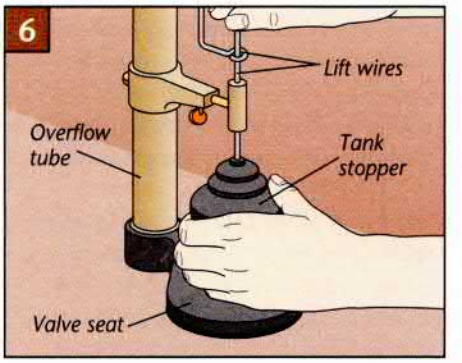
Assemble the gasket on the new flush valve; insert the assembly through the tank bottom. Position the overflow tube; assemble the conical gasket and locknut; tighten.



To install a stopper with lift wires, slide the guide rod and collar down the overflow tube. Center the guide rod over the valve seat and tighten the adjustment screw.



Hook the upper lift wire into the trip lever. Slide the lower lift wire down through the upper wire and the guide rod. Adjust the rod's height with the adjustment screw.



Screw the tank stopper onto the lower lift wire so the stopper will drop straight down. Reposition the bowl-refill tube and reconnect the tank, reversing the above steps.

PROFESSIONAL TIPS

DETECTING A TANK LEAK

If you can't tell whether your toilet is leaking around the tank bolts or just sweating, add food coloring to the tank water. Wait an hour; then touch the bolt tips and nuts under the tank with white tissue. If the tissue shows coloring, you have a leak; otherwise, it's condensation. For remedies to either of these problems, see page 131.

Clogged Toilets

If you suspect a toilet is clogged, don't flush or it may overflow.

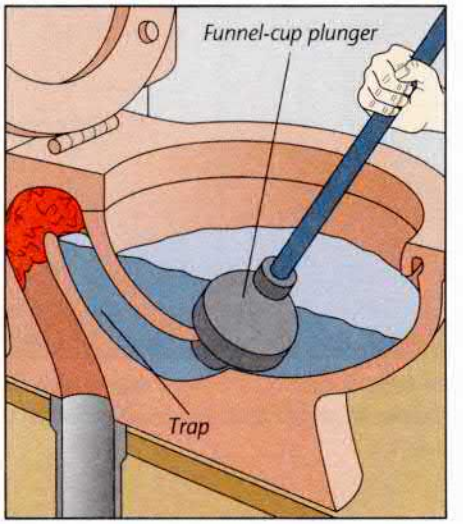
To unclog the toilet, first bail out or add water so that the bowl is half full. Then use a funnel-cup plunger, specially designed to fit the bowl's trap. If the plunger doesn't clear the clog, use a closet auger *(page 21)*. Its curved tip reaches deep-set clogs and its protective housing won't scratch the bowl.

QUICK FIX-UP

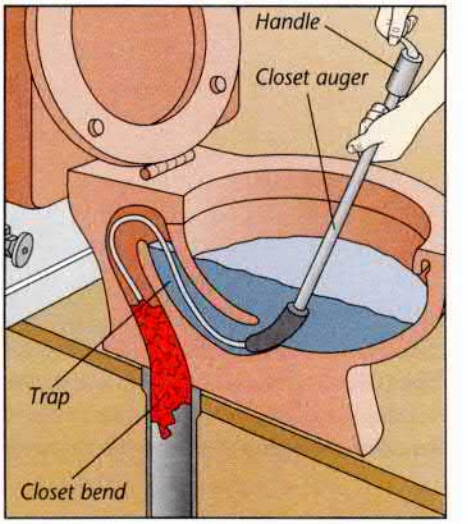
PREVENTING AN OVERFLOW

If a toilet is about to overflow, quickly reach into the tank; push the tank stopper down into the valve seat and hold it while you turn off the water.

Two ways to unclog a toilet trap



Use a funnel-cup plunger to dislodge a clog in the toilet trap. Rapidly pump the plunger a dozen times or more to push the obstruction through the trap.



Use a closet auger to break up a deep-set clog in the toilet trap or closet bend. To maneuver the auger, simultaneously push it and turn the handle.

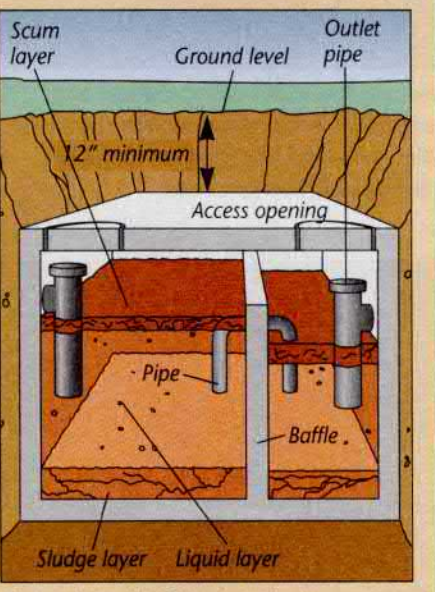
Maintaining Your Septic Tank

A good septic tank system doesn't require much maintenance or call for many special precautions. But the maintenance it does require is crucial, since failure of the system can constitute a serious health hazard. You should have a complete diagram of your septic tank's layout, showing the location of the tank, pipes, manholes, and disposal field. If you don't, the information may be on a lot plan filed with the county or city building department.

Chemicals, drain cleaners with lye, and thick paper products should never be disposed of through the system. Some chemicals destroy the bacteria necessary to attack and disintegrate solid wastes in the septic tank. Paper products can clog the main drain to the tank and smaller pipes to the disposal field, making the entire system useless. Also, don't let cooking grease enter the system; it will coat the surface of the earth in the disposal field and prevent proper absorption into the soil.

Have your septic tank checked by a professional about once a year. To function properly, the tank must maintain a balance of sludge (solids remaining on the bottom), scum (gases containing small solid particles), and liquid, as shown in the drawing at right. The proportion of the sludge and scum layers to the liquid layer determines whether pumping is needed.

Have your septic tank pumped by a professional whenever necessary to remove sludge and some of the scum. The best time to do the work is in the spring, since during the winter the bacterial action is slowed down and the tank will have become loaded with solid waste.



This schematic drawing shows sludge, liquid, and scum layers in a concrete tank.

Leaks, Tank Sweating, & Flush Problems

Other toilet problems you may need to repair include leaks, tank sweating, and certain flush problems.

CAUTION: Some repairs require an empty tank. When this is the case, turn off the water at the fixture shutoff valve; flush the toilet and sponge the tank dry before doing the repair.

Leaks. Toilet leaks, a common problem, may be confused with toilet sweating. For a tip on how to detect leaks, see page 129.

To stop a leak between the tank and bowl of a bowl-mounted toilet tank, tighten the bolts in the tank, or remove them and replace their gaskets. To seal the connections on a wall-mounted tank, tighten the couplings on the pipe connecting the tank and bowl, or unscrew the couplings, remove the pipe, and reverse the removal procedure to replace the washers.

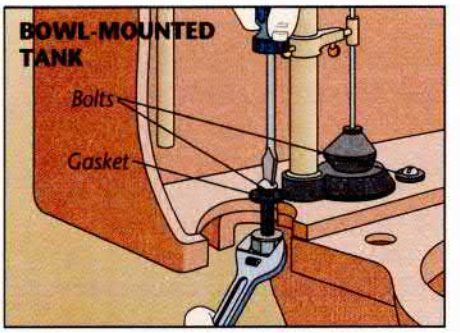
If the bowl leaks around its base, you'll have to remove the bowl and reseal at the waste pipe. If you don't want to do this job yourself, call in a professional plumber.

Tank sweating. This problem occurs most often in the summer when cold water in the tank cools the porcelain and warm, moist air condenses on the outside. Tank sweating encourages mildew, loosens floor tiles, and rots subflooring.

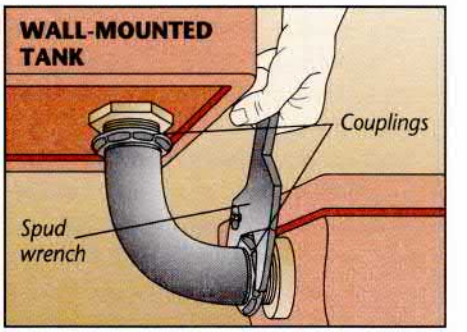
An easy solution is to insulate the inside of the tank by draining it and then gluing a liner made of foam rubber or polystyrene pads to the inside walls. A more costly remedy, and one that will add to your energy costs, is to install a tempering valve that mixes hot water with the cold water entering the tank. This is a job best left to a professional.

Flush problems. A loose handle or trip lever can cause an inadequate or erratic flush cycle. Adjusting the setscrew on the handle or lever or replacing the handle can often solve the problem. Clogged flush passages under the bowl's rim may also be restricting water flow. Clean obstructed passages with a piece of wire.

Fixing a leaky tank

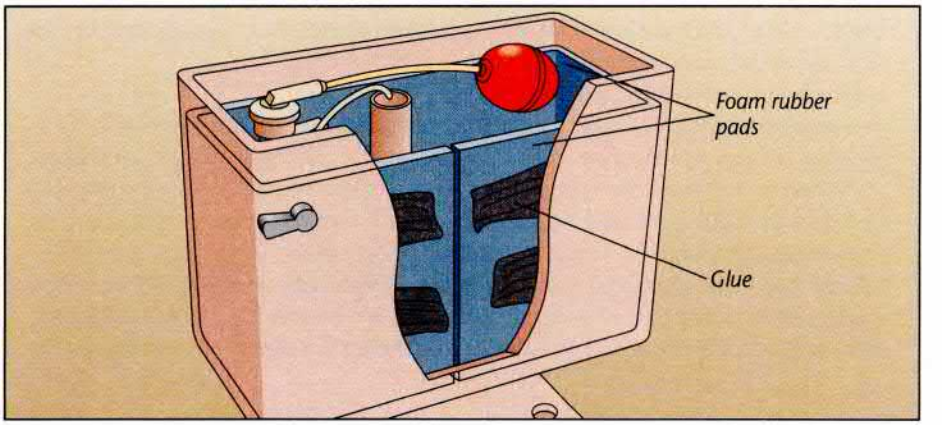


Tighten the bolts between the tank and bowl of a bowl-mounted tank or replace their gaskets if damaged.



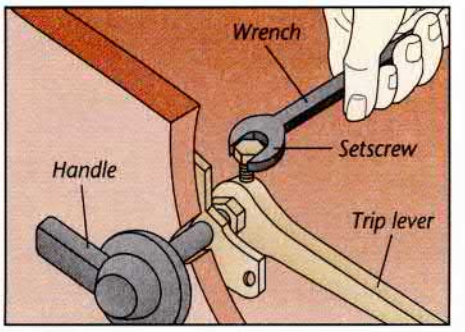
Tighten the couplings on the connecting pipe of a wall-mounted tank or remove the pipe and replace the washers (not shown).

Preventing tank sweating

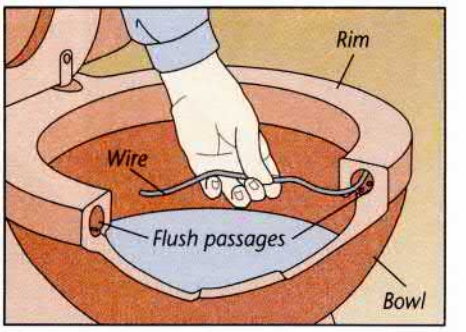


Glue pieces of foam or polystyrene 1/2 inch thick to the inside of the tank. Be sure it doesn't touch moving parts.

Solving flush problems



Tighten the setscrew on a loose handle or trip lever with a wrench.



Use a thin piece of wire to clean out a blockage in the bowl's flush passages.

Face-lifts for Fixtures

As time goes by, moisture and daily use take their toll on plumbing fixtures. Once-gleaming porcelain and fiberglass surfaces can become dull, discolored, or damaged. Separations can appear where the bathtub joins the wall.

Before you put a stained, chipped, or cracked fixture out to pasture, consider giving it a face-lift with some bleach, touch-up paint, glue, or caulk. You can even have it professionally recoated with an epoxy coating. Look up "Bathtubs and Sink, Repair and Refinishing" in the Yellow Pages. Often, such repairs can extend the life of an aging fixture, postponing installation of a replacement.

Stains and mineral deposits. You can renew a fixture by removing discoloration, rust stains, and mineral deposits. An effective treatment for discoloration and rust stains is a liquid chlorine bleach solution. Commercial products are available to remove mineral deposits. For a homemade approach to improving the appearance of an enameled fixture, polish with a mixture of cream of tartar and peroxide.

To remove rust stains from porcelain or fiberglass, try rubbing the stain with a cut lemon or try applying lemon juice. If the fixture is badly stained, use a 5 percent solution of oxalic acid or a 10 percent solution of hydrochloric acid. Apply the acid solution with a cloth and leave it on only a second or two; then rinse it off thoroughly. Be sure to protect your skin and eyes by wearing rubber or plastic gloves and protective goggles.

Small scratches and chips. You can cover a small scratched or chipped area of porcelain or fiberglass by building up thin coats of enamel paint or epoxy paint, available in touch-up kits in many colors to match the color of your fixture.

Before applying the paint, clean the surface of the damaged area with alcohol. Then check that the area is clean, dry, and dust-free. Using a small brush, apply several coats of touch-up paint, blending it toward the edges of the scratch or chip. Allow the paint to dry for about an hour between coats; keep the touched-up area dry for 24 hours. Don't expect the result to be perfect—you may be able to see where the touch-up was applied once the paint has dried.

Large chips. If the corner or edge of a porcelain or fiberglass fixture has broken off and you have the chip, you can glue it back in place with epoxy resin. Again, be sure the surfaces are entirely clean and dry. Depending on the label directions, coat one or both surfaces with adhesive and press the pieces together firmly. Use masking tape to secure the repair for at least an hour. Keep the area dry overnight.

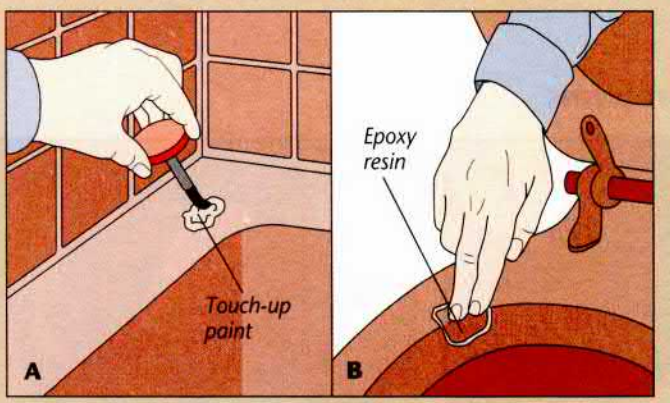
Separated bathtub-wall joint. One of the most common bathroom repairs is sealing cracks in the joint between the bathtub and the wall. It's a chore you'll have to repeat every year or so because the weight of the tub changes as it's filled and emptied again and again.

The simplest way to seal the troublesome joint is with flexible waterproof caulking compound (fill the tub with water first), sometimes called plastic tub-and-tile sealer. The sealer comes in a tube. *(For information about common types of caulking compounds, see page 25.)*

Before applying the sealer, scrape away the old caulking. Clean and dry the area thoroughly to ensure a good seal. Holding the tube at a 45° angle, slowly squeeze the sealer into the joint, using a steady, continuous motion. If you can do each side of the tub without stopping, the line of caulking will be smoother, making the repair less noticeable.

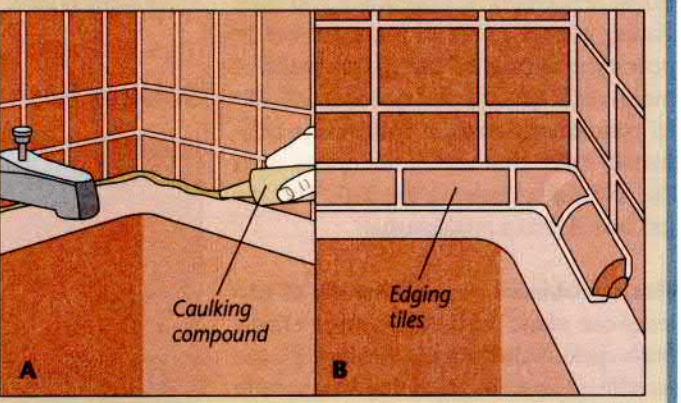
If the bathtub-wall gap is wide or uneven, apply decorative quarter-round ceramic edging tiles. Available in kits, the tiles are installed around the tub rim using the caulking compound just described as an adhesive. Remove old caulking and clean and dry the area before you begin.

Mending chipped fixtures



Apply enamel or epoxy touch-up paint on a small scratch or chip (A). If possible, glue the chip back on with epoxy resin (B).

Sealing a tub-wall joint



Seal a tub-wall separation with a continuous bead of caulking (A) or install quarter-round ceramic edging tiles (B).

Leaking Pipes

A higher than normal water bill might be your first indication of a leaking pipe. Or you might hear the sound of running water even when all your fixtures have been turned off.

When you suspect a leak, check the fixtures first to make sure all the faucets are tightly closed. Then go to the water meter, if you have one. If the dial is moving, you're losing water somewhere in the system.

Locating the leak. Finding the leak isn't always easy. The sound of running water helps; if you hear it, follow it to its source. You can buy or rent a listening device that amplifies sounds when held up to a pipe.

If water is staining the ceiling or dripping down, the leak is probably directly above. Occasionally, though, water may travel along a joist and then stain or drip at a point some distance from the leak. If water stains a wall, it means there's a leak in a section of pipe. Any wall stain is likely to be below the actual location of the leak, and you'll probably need to remove part of the wall to find it.

Without the sound of running water and without drips or stains as evidence, leaks are more difficult to find. Using a flashlight, check all the pipes in the basement or in the crawl space.

Fixing the leak. If the leak is major, turn off the water immediately, either at the fixture shutoff valve or the main shutoff valve. You'll probably have to replace the leaky section of pipe. If your experience working with pipes is limited, consider calling in a plumber to do the job.

If the leak is small, the ultimate solution is to replace the pipe; but there are temporary solutions until you have time for the replacement job. These methods work for small leaks only.

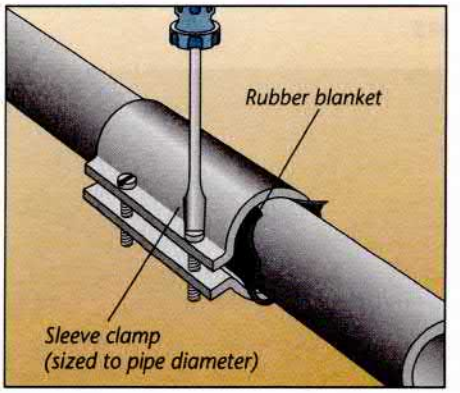
Clamps should stop most leaks for several months if they're used with a solid rubber blanket. It's a good idea to buy a sheet of rubber, as well as some clamps sized to fit your pipes, at a hardware store and keep them on hand in the event of such an emergency.

A sleeve clamp that exactly fits the pipe diameter works best. Wrap a rubber blanket over the leak, then screw the clamp down over the blanket. An adjustable hose clamp used with a rubber blanket stops a pinhole leak. If nothing else is at hand, use a C-clamp, a small block of wood, and a rubber blanket.

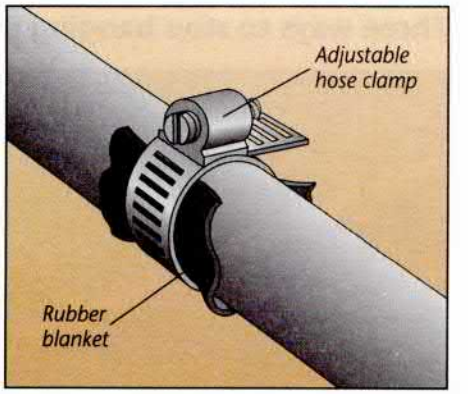
In a pinch, try applying epoxy putty around a joint where a clamp won't work. The pipe must be dry for the putty to adhere. Turn off the water supply to the leak and leave the water off until the putty hardens completely on the pipe.

If you don't have a clamp or putty, you can still stop a small leak temporarily by plugging it with a pencil point *(see the Quick Fix-up below)*.

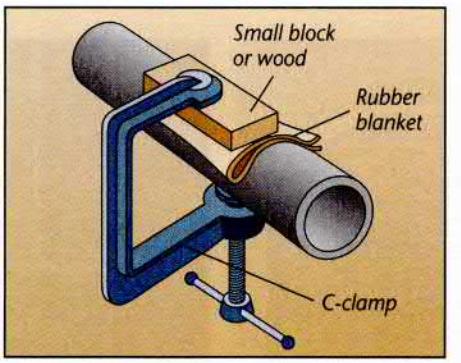
Four ways to stop a small leak



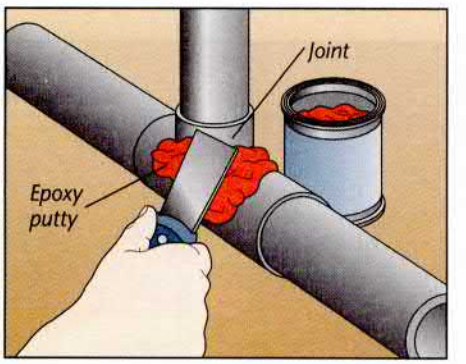
Place a sleeve clamp over a rubber blanket at the place where the pipe leaks. Screw the clamp down tightly.



Position an adjustable hose clamp around a rubber blanket over a small pipe leak and tighten the clamp.



Secure a C-clamp and a small block of wood over a rubber blanket for a small leak.



Apply epoxy putty to a leaking pipe joint (after turning off the water), using a putty knife or your fingers. Let the joint dry.

QUICK FIX-UP

STOPPING A SMALL LEAK

You can temporarily plug a small pipe leak by breaking off a pencil point in the hole. Then wrap the pipe with three layers of electrical tape, extending the tape 3 inches on each side of the leak.

...WATER PIPES

Noisy Pipes

Pipe noises range from loud hammering sounds to high-pitched squeaks. The causes may be loose pipes, waterlogged air chambers, or water pressure that's too high. Anchoring exposed pipes is a simple solution; other remedies, such as anchoring pipes concealed inside walls, floors, or ceilings, may call for a professional.

Banging. Pipes are usually anchored with metal pipe straps every 6 to 8 feet for horizontal runs, 8 to 10 feet for vertical runs. If your pipes bang when you turn on the water, you may need to add straps, cushion the pipes with a rubber blanket, or both. When you anchor a pipe—especially a plastic one—leave room for expansion. Also, galvanized straps should never be used on copper pipes.

Squeaking. Only hot water pipes squeak. As the pipe expands, it moves in its strap and friction causes the squeak. Solution: Cushion it as you would a banging pipe.

Water hammer. This noise occurs when you turn off the water at a faucet or an appliance quickly. The water flowing through the pipes slams to a stop, causing a hammering noise. The cause could be loose pipes. To remedy this, anchor them as shown below.

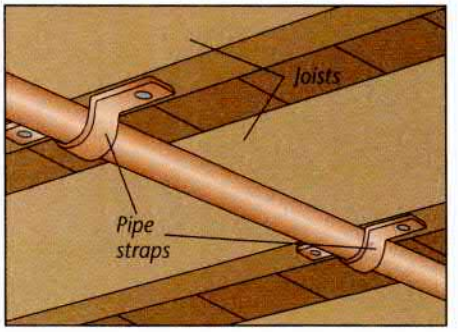
In some homes, the problem may be faulty air chambers *(see below)*.

These lengths of pipe, installed behind fixtures and appliances, hold air that cushions the shock when flowing water is shut off. They can get filled with water and lose their effectiveness.

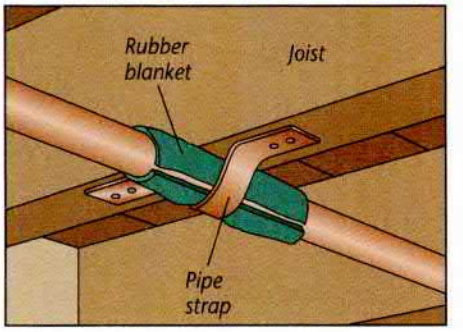
To restore air to the chambers, turn off the water at the main shutoff valve *(page 7)* and open all the faucets to drain the system. Close the faucets and turn the water on again. The air chambers should fill with air.

Another cause of water hammer is water pressure that's above 80 psi (pounds of pressure per square inch). To lower the pressure, install a pressure-reducing valve (you can call in a plumber to do the work if don't want to do the job yourself).

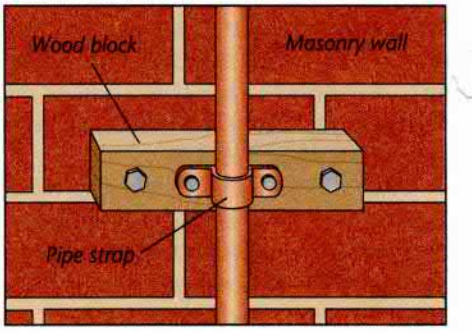
Three ways to stop banging pipes



Nail additional pipe straps to joists to stop horizontal pipes from vibrating.

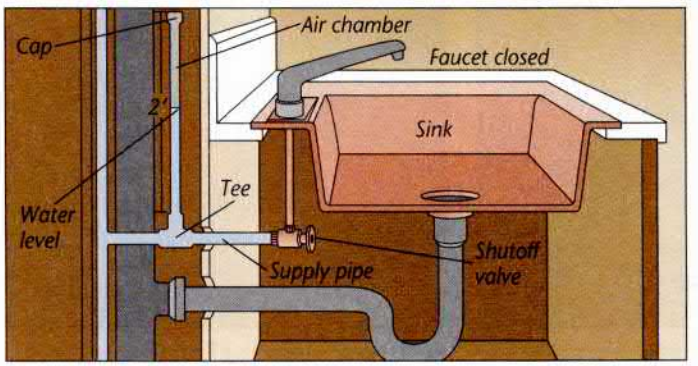


Wrap a rubber blanket or piece of hose around a noisy pipe to cushion it in its strap.

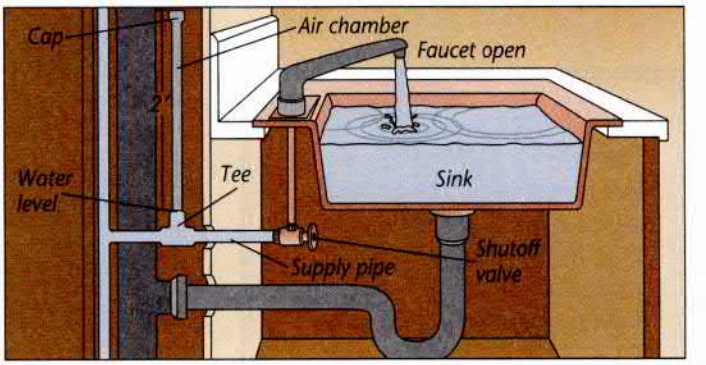


Fasten a wood block to a masonry wall with lag screws and anchors; strap on pipe.

How an air chamber works



When the faucet is closed, the moving water stops at the faucet and rises up into the air chamber.



When the faucet is open, the water flows up the supply pipe and out the faucet, without moving up into the air chamber.

Frozen Pipes

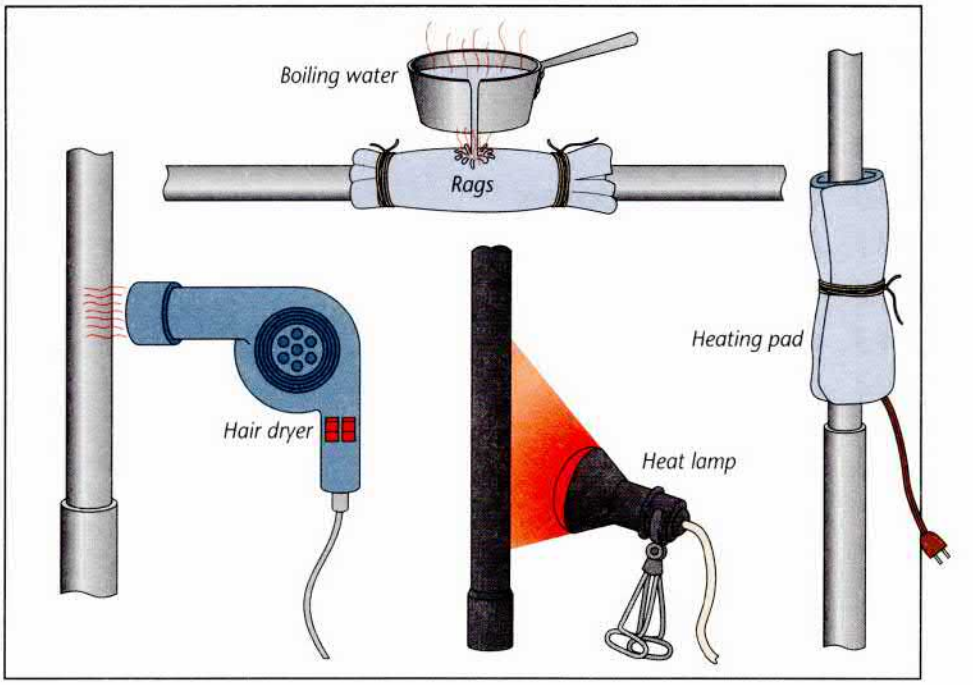
A faucet that won't yield water is the first sign of frozen pipes. If a severe cold snap hits, prevent freezing and subsequent bursting of pipes by following the suggestions below. Even if the pipes do freeze, you can thaw them before they burst if you act quickly.

Preventing frozen pipes. When temperatures fall very low, here's how to keep your pipes from freezing:

- Keep a constant trickle of water running from the faucets.
- Beam a heat lamp or direct a small heater at exposed pipes.
- Wrap uninsulated pipes with newspapers, heating wires, foam padding, or self-adhesive insulating tape.
- Keep doors ajar between heated and unheated rooms.

Thawing frozen pipes. If a pipe freezes, first shut off the water at the main shutoff valve *(page 7)* and open the faucet nearest the frozen pipe so it can drain as it thaws. Waterproof the area with containers as well as plastic dropcloths in case leaks occur; then use one of the following methods to gradually warm the frozen pipe. Be sure to work from the faucet toward the iced-up area. Remember to exercise extreme caution when using electrical appliances—such as a hair dryer or heat lamp—when around water.

A variety of pipe-thawing techniques



- **Hot water.** The safest of these methods for thawing a frozen pipe is to wrap the pipe (except plastic) in rags and pour boiling water on it.
- **Heating pad.** Wrap a length of pipe with a heating pad.
- **Hair dryer.** Used like the torch, a hair dryer will gently defrost the frozen pipe. (Again, exercise extreme caution near water.)
- **Heat lamp.** For pipes situated behind walls, floors, or ceilings, beam a heat lamp 8 or more inches from the surface of the pipe.

Winterizing Your Plumbing System

People who leave their homes for extended periods in winter are now closing down the plumbing system because of prohibitively high energy costs. Winterizing your plumbing is a virtually cost-free way to avoid frozen pipes.

First, turn off the main shutoff valve *(page 7)* or have the water company turn off water service to the house. Starting at the top floor, open all faucets, both indoors and outside.

When the last of the water has dripped from the taps, open the plug at the main shutoff valve, if possible (you may have to contact the water company for help), and let it drain.

Turn off the power or gas to the water heater and open its drain valve.

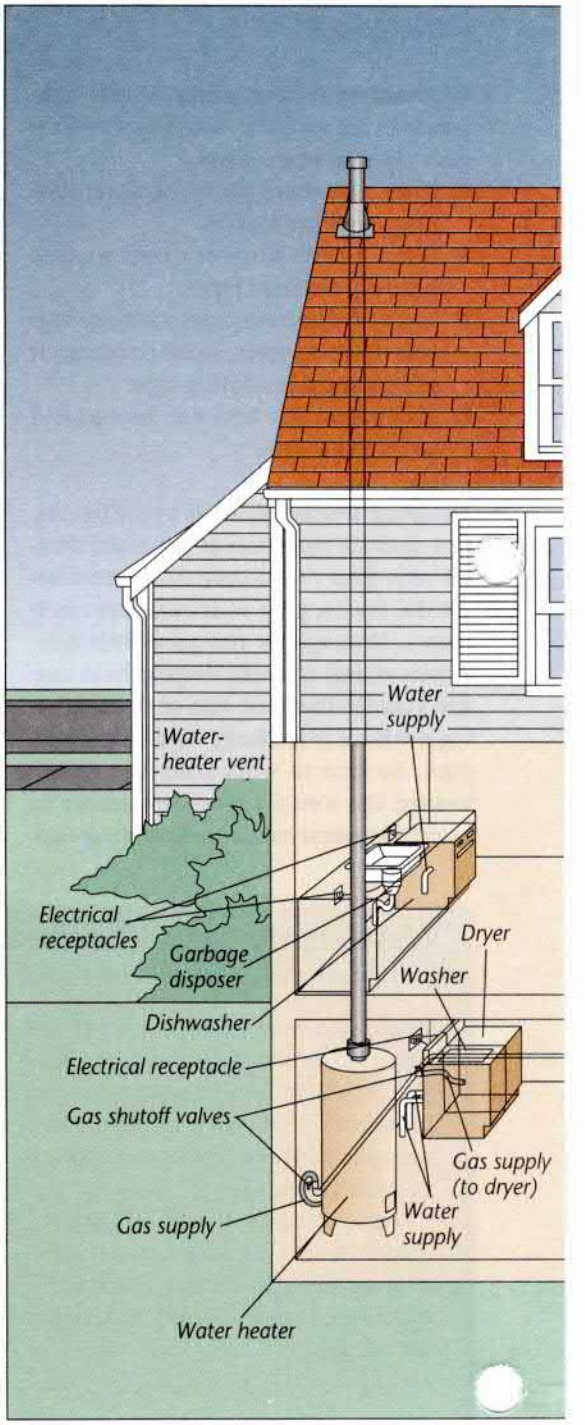
To freezeproof the system, empty toilet bowls and tanks. Remove the cleanout plugs on all sink traps or remove the traps, if necessary *(page 122)*. Once emptied, replace them and fill with low temperature windshield fluid or recreational vehicle (RV) antifreeze (regular antifreeze is forbidden in many places and is harmful to septic systems). Do the same with the basement floor drain or main house trap (if any).

You won't be able to drain tub and shower traps. Instead, add at least a quart of RV antifreeze or windshield fluid.

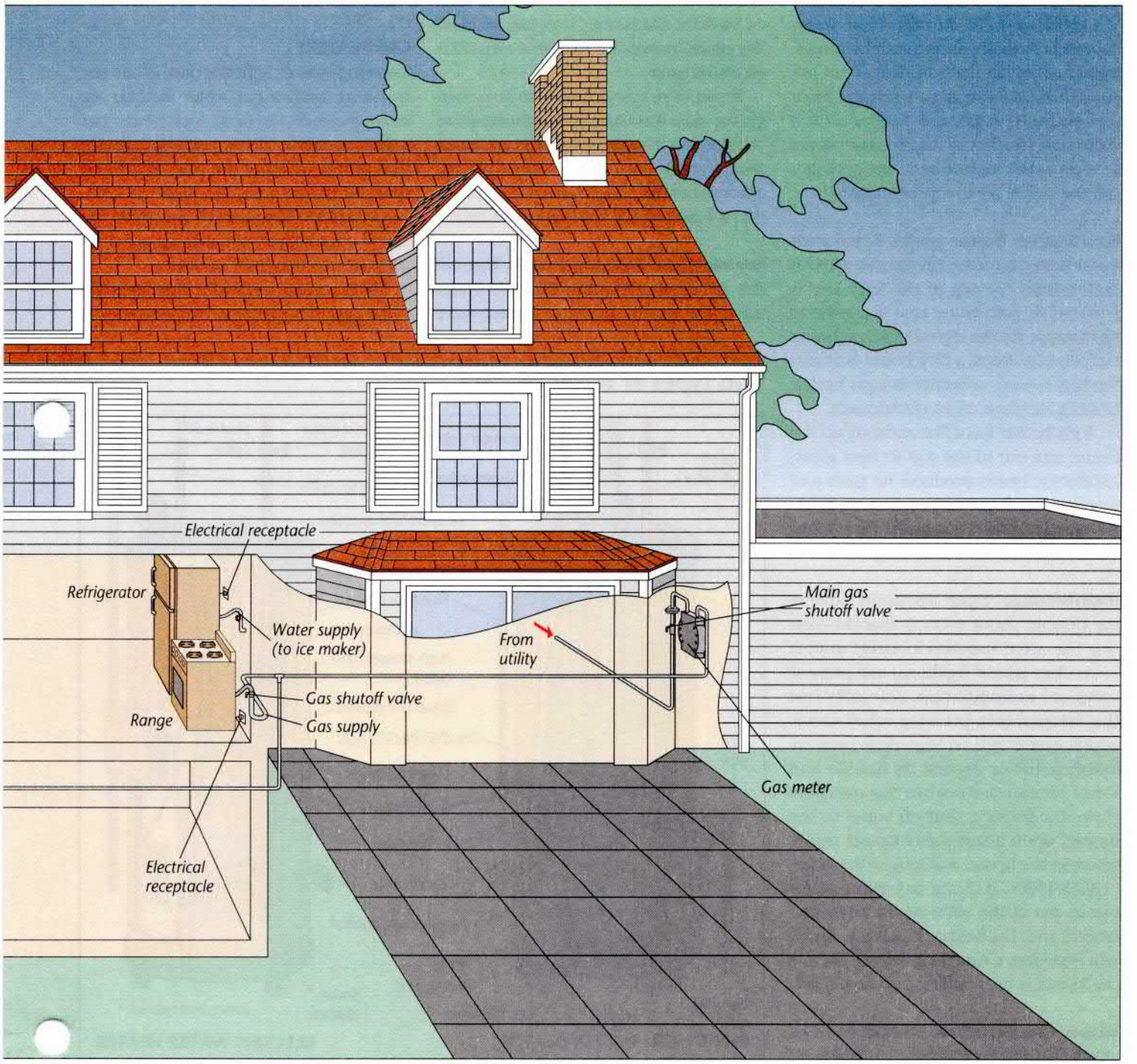
Don't put either fluid into a dishwasher or clothes washer.

Major Appliances

138 Water Heaters
140 Garbage Disposers
141 Dishwashers
142 Clothes Washers
143 Clothes Dryers
144 Kitchen Ranges
146 Refrigerators



The appliances shown below—refrigerator, range, dishwasher, garbage disposer, washer, dryer, and water heater—have today become standard equipment in most homes. Should you experience problems with any of these appliances, turn to the appropriate diagnostic and repair guide in this chapter.



WATER HEATERS

There are two types of water heaters: storage type and on-demand type. The more common storage type is pictured below. On-demand heaters are situated close to the area of need and do not "heat and store" hot water, thus reducing operating costs. Installation and maintenance of on-demand heaters is best left to a pro.

Problems with storage type water heaters are usually announced by noises, leaks, or by water that's too hot or not hot enough. Often you can correct the problem yourself. A possible exception is a water leak, which may require professional service or tank replacement. For gas leaks, call the utility company immediately.

How a water heater works. When a hot water faucet is turned on, heated water is drawn from the top of the tank and is replaced by cold water that is carried to the bottom via the dip tube. When water temperature drops, a thermostat activates the heat source—a burner in a gas heater, heating elements in an electric unit.

A gas heater has a flue running up the center and out of the top to vent gases. An electric heater produces no gases and therefore needs no venting. In both, a special anode attracts corrosion that might otherwise attack the tank's walls.

Maintenance. Open the drain valve at the bottom about every 6 months—letting the water run into a bucket until it looks clear (about 5 gallons) will prevent sediment accumulation. Annually test the temperature-pressure relief valve, which guards against hazardous pressure buildup: lift or depress its handle and water should drain from the overflow pipe; if it doesn't, shut off water to the heater, open a hot water faucet somewhere in the house, and replace the valve.

CAUTION: If steam or boiling water comes out of the valve or the hot water faucets, shut the heater off at once. And if you ever hear a rumbling sound, assume the heater is overheating and turn it off.

Water temperature. On gas heaters, check that the temperature control is set correctly (normally 150-160°F, lower if there's no dishwasher or for safety if you have small children). If you suspect a faulty control, open a hot water faucet for 3 minutes. If the heater doesn't turn on, reset the control to a lower temperature and test again. If it still fails, replace the heater. Long pipe runs let water cool en route to the faucet. You can insulate the pipes, move the heater, or install a second heater.

If you have an old heater, to save energy, consider installing an insulating-foam or fiberglass heater jacket; kits are available. If you're unsure about how to install a jacket, consult a professional. Also check that a jacket won't void your warranty.

Draining and flushing a tank. Turn off the gas or power, close the cold water valve, and attach a hose to the drain valve to route water into a drain or outdoors. Open the drain valve and open one hot water faucet to let in air. When all water has drained, turn the cold water valve on and off until the water from the drain looks clear. Then close the drain valve and the hot water faucet, open the cold water valve, and turn the power back on.

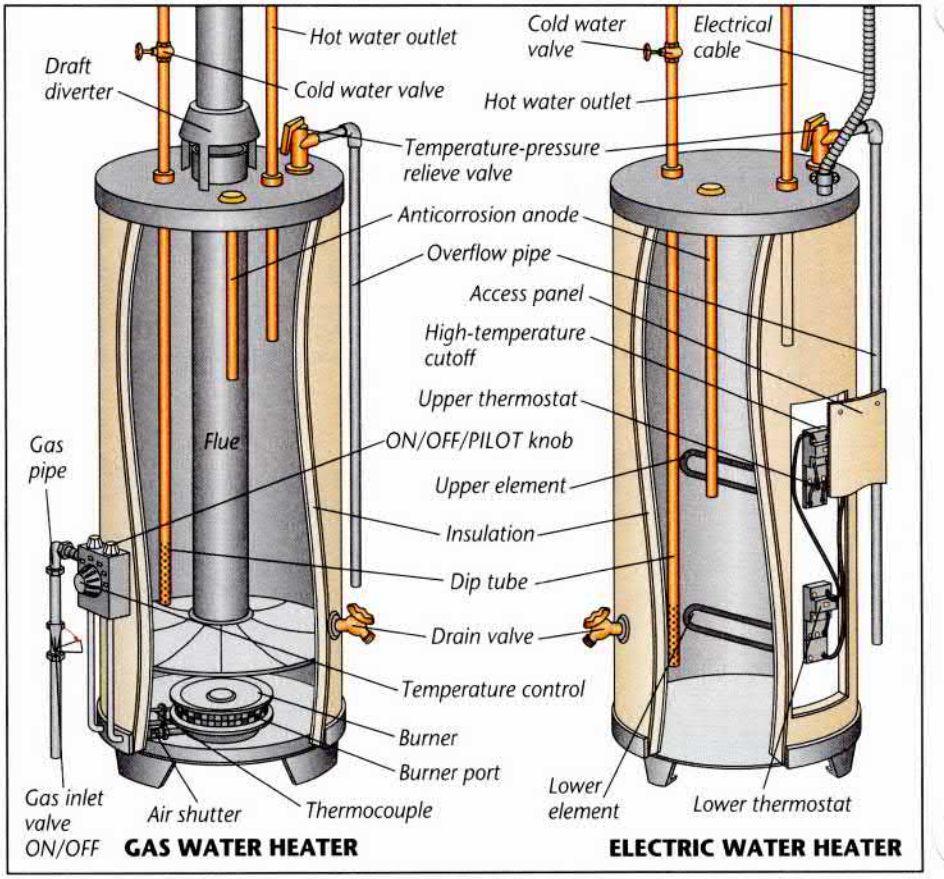
GAS HEATERS

Knowing how to light the pilot is one key to living with a gas water heater; see instructions on the tank. A gas heater has a thermocouple, a thermoelectric device that senses whether the pilot is on and shuts off the gas if the pilot light goes out.

CAUTION: If you smell gas, leave the house immediately and call the gas company from a neighbor's phone.

Twice a year, inspect the flue assembly to be sure it's properly aligned and its

Two types of water heaters



joints are sealed. Then check the flue by placing your hand near the draft diverter (with the burner on); air flowing out indicates an obstruction that should be removed. To ensure burner function, every year or two, shut off the gas, remove the access panel, and clean the burner ports using a stiff wire. NOTE: Air shutter and flame adjustments are beyond the abilities of most homeowners; call a pro.

ELECTRIC HEATERS

When an electric heater has problems, suspect the heating elements, their thermostats, and the high-temperature cutoff. The two heating elements (upper and lower) are controlled by thermostats which, along with the high-temperature cutoff, are concealed behind an access panel on the side of the water heater (insulation may also need to be cut away for access after removing the panel). If the high temperature cutoff has tripped due to water that's too hot, the solution may be as easy as pushing the reset button. High voltage and inaccessibility warrant a service call to have the thermostats adjusted, the high-temperature cutoff reset, or any of these components—or the heating elements themselves—replaced.

Troubleshooting a water heater

PROBLEM	POSSIBLE CAUSE	REMEDIES
No hot water	(G) (E) Temperature control or thermostat off, or defective	(G) Turn temperature control up, or test *(see text)*; **if defective, replace***
		(E) Replace defective thermostat*
	(G) Pilot light out	Relight pilot *(see instructions on tank)*
	(G) Closed gas inlet valve	Turn handle parallel to gas line; relight pilot
	(G) Pilot won't light	Clean orifice; **if defective, replace thermocouple***
	(G) Burner won't light (pilot on)	Turn temperature control to ON; adjust pilot *(page 176)*
	(E) Power off at heater	Check heater master switch and circuit breaker or fuse *(pages 151-152)*
	(E) Defective heating element	**Replace element (preferably both elements)***
	(E) Tripped high-temperature cutoff	**Remove panel and push reset button***
Too little hot water or water not hot enough	(E) (G) Temperature control or thermostat too low, or defective	(G) Turn temperature control up, or test *(see text)*; **if defective, replace***
		(E) Turn thermostat up, **or replace***
	(G) Burner flame not blue	**Adjust shutter on burner***
	(G) Clogged burner ports	Clean burner ports with stiff wire
	(G) Slow heater recovery	Clean burner ports with stiff wire; flush tank
	(E) Defective heating element	**Replace element (preferably both elements)***
	(E) Low voltage	Call electrician
Water excessively hot	(E) (G) Temperature control or thermostat too high, or defective	(G) Turn temperature control down; **if defective, replace***
		(E) Turn thermostat down, **or replace*** *(see "Noises")*
	(G) Blocked flue	Disassemble flue and clear obstruction
	(E) Defective heating element or high-temperature cutoff	**Replace defective part***
Noises		
Rumbling	(G) (E) Overheating	Carefully open temperature-relief valve; if steam or boiling water escapes, shut heater off immediately
Whistling/sizzling	(E) Sediment buildup in tank	Drain and flush tank *(see text)*
	(E) Encrusted heating elements	**Replace elements***
Rumbling/cracking	(G) Sediment buildup in tank	Drain and flush tank *(see text)*
Leaking water	(G) (E) Leaking drain valve	Tighten valve; replace plastic drain valve with brass valve
	(G) (E) Temperature-pressure relief valve open	Close valve; **if defective, replace***
	(G) (E) Corroded tank	**Replace heater***
	(E) Leaking heating elements	**Tighten mounting bolts and replace gaskets***

(E) Electric heater only *(G) Gas heater only* ***This repair is best left to a professional.***
Appliance models vary; see your owner's manual for information specific to your water heater.

GARBAGE DISPOSERS

The two types of garbage disposers are batch-feed (activated by turning a stopper) and continuous-feed (activated by a wall switch). Problems usually involve jams or clogs, or occasionally leaks.

CAUTION: If dismantling a disposer, unplug the unit or shut off power at the service panel *(page 152)*. Never put your hand in the disposer—use pliers or tongs to remove an object. And never pour a chemical drain cleaner into a disposer or you may damage the unit.

If your disposer makes a loud whirring noise or stops, it has jammed. Turn it off and wait 5 minutes; then firmly press the reset button on the bottom of the motor housing. (Machines without buttons are designed to reset automatically.)

If the disposer still doesn't work, see if it's designed to be unjammed from below—it may have a small crank (or a socket for an Allen wrench) to turn the flywheel. Or it may have a reversing switch. If neither of these features is present, angle a broom handle against an impeller blade and work the blade back and forth until you dislodge the jam. Then press the reset button.

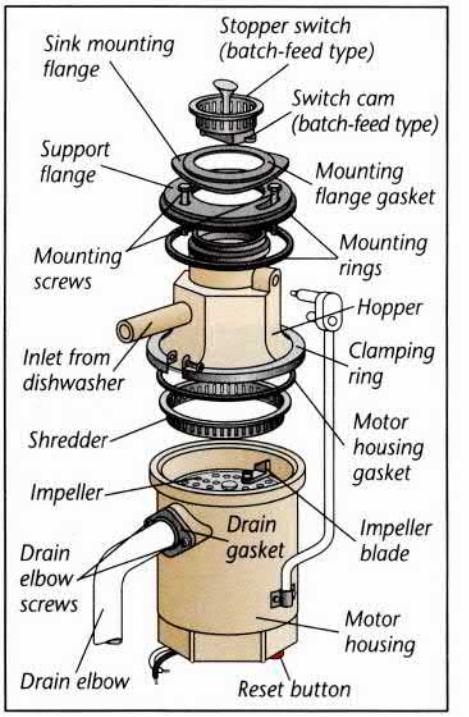
To cure a clog, disassemble the trap and use a snake *(page 121)*.

Water dripping from the disposer usually indicates one or more seals are worn and need to be replaced.

Most professionals service disposers in the home. If a unit needs to come to the shop for work, many companies will loan you a disposer so you can maintain normal sink usage. If you need to remove a disposer, separate it from the drain elbow and loosen the mounting screws to release it from the support flange.

For best service from your disposer, run cold water during disposal and for a minute after. And be careful about what you put in it—never try to dispose of glass, metal, or rubber. Disposers vary in design, so consult your owner's manual for more detailed information.

Parts of a disposer



Troubleshooting a garbage disposer

PROBLEM	POSSIBLE CAUSE	REMEDIES
Disposer doesn't run; no sound	Power off to circuit	Check circuit breaker or fuse *(pages 151-152)*
	Defective motor	**Repair or replace motor***
	Tripped overload switch	Push reset button firmly (if no button, wait for switch to reset automatically)
	Faulty switch	Replace wall switch *(pages 158-159)* or stopper
Disposer doesn't run; motor hums	Jammed impeller	Clear jam *(see text)*; push reset button firmly (if no button, wait for switch to reset automatically)
Disposer runs only intermittently or won't shut off	Defective switch or worn switch cam	Replace wall switch *(pages 158-159)* or stopper
Disposer grinds improperly	Insufficient water flow	Open cold water faucet fully
	Unsuitable waste in disposer	Remove waste *(see owner's manual)*
	Broken impeller blade or dull shredder	**Replace blade or shredder***
Water leaks from disposer	Loose drain elbow	Tighten drain elbow screws or replace drain gasket
	Badly sealed motor housing and hopper	Replace motor housing gasket
	Sink-mounting flange not sealed	Tighten mounting screws or replace gasket
Disposer noisy	Foreign object in disposer	Remove object with pliers or tongs
	Loose mounting screws	Tighten mounting screws
	Broken impeller blade	**Replace blade or impeller***
	Defective motor	**Repair or replace motor***

***This repair is best left to a professional.** Appliance models vary; see your owner's manual for information specific to your garbage disposer.*

DISHWASHERS

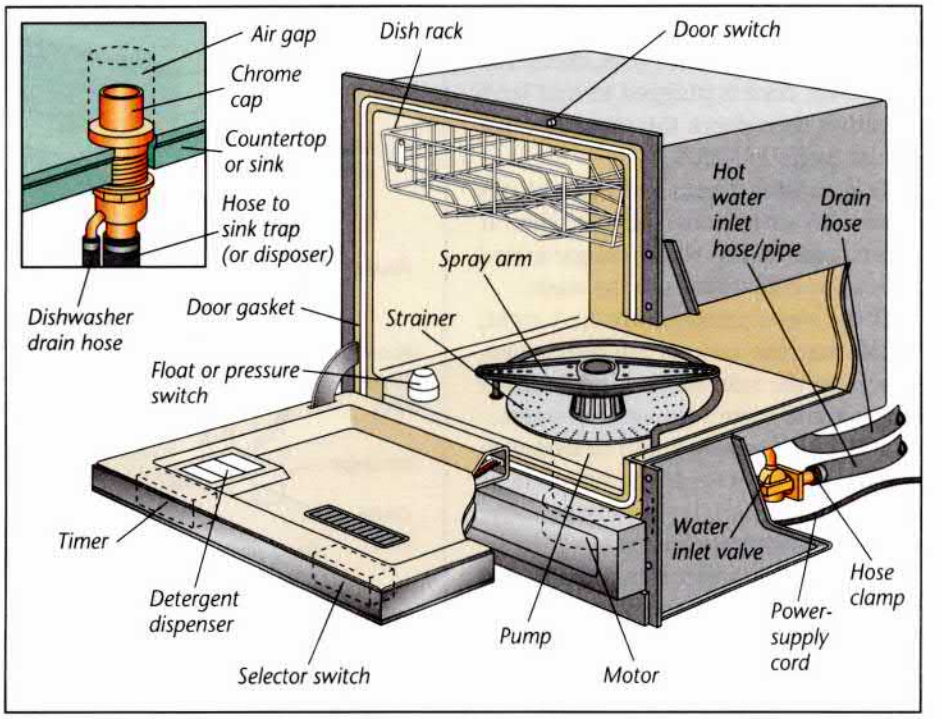
Assuming a properly functioning dishwasher, there are three essential elements for good dishwashing: Water that is 140°F; water that is of less than 15 grains of hardness; and a proper amount of detergent (1 teaspoon of detergent for each grain of water hardness).

Dishwasher leaks represent the most common problems. Oversudsing caused by too much detergent is often the cause.

Beyond basic leak diagnosis and repairs, dishwasher troubleshooting can be troublesome because of the difficulty in determining which component is the culprit. Most parts are expensive, but they carry manufacturer's warranties that can extend up to 10 years. Use the illustration and chart to guide you through the various problems and their remedies.

CAUTION: Before making dishwasher repairs, shut off power to it at the service panel. Turn off its water supply under the sink before working on the inlet valve or disconnecting the water hose.

Parts of a dishwasher



Troubleshooting a dishwasher

PROBLEM	POSSIBLE CAUSE	REMEDIES
Dishwasher leaks	Faulty hose connection	Tighten hose clamps or replace hose
	Door gasket not sealing	Replace door gasket
	Dishes deflecting water	Reposition dishes
Dishwasher runs noisily	Low water level	Clean or replace screen on water inlet valve
	Defective water inlet valve	**Replace water inlet valve***
Dishwasher doesn't run	Door not fully closed	Close door tightly
	Defective door switch	**Replace switch***
	Defective timer or selector switch	**Replace timer or selector switch***
Dishwasher won't fill	Blocked water inlet valve screen	Clean screen **or replace water inlet valve***
	Faulty water inlet valve	**Repair or replace water inlet valve***
	Jammed float switch or defective pressure switch	Remove obstruction from beneath float; **replace pressure switch if defective***
	Defective timer or selector switch	**Replace timer or selector switch***
Dishwasher continues to fill	Defective water inlet valve	**Repair or replace water inlet valve***
	Blocked fill spout in water inlet valve	**Disassemble valve and clean fill spout***
	Defective timer or selector switch	**Replace timer or selector switch***
	Jammed float switch or defective pressure switch	Remove obstruction from float; **replace pressure switch if defective***
Dishwasher won't drain	Dirty air gap	Clean air gap with wire
	Plugged strainer	Remove strainer and clean with brush
	Defective drain valve	**Repair or replace drain valve***

***This repair is best left to a professional.** Appliance models vary; see your owner's manual for information specific to your dishwasher.*

CLOTHES WASHERS

Clothes washers come in many different designs. The illustration shows a traditional top-loading machine.

If your washer doesn't work, check that the power cord is plugged in and isn't defective; then check the circuit breaker or fuse *(pages 151-152)*.

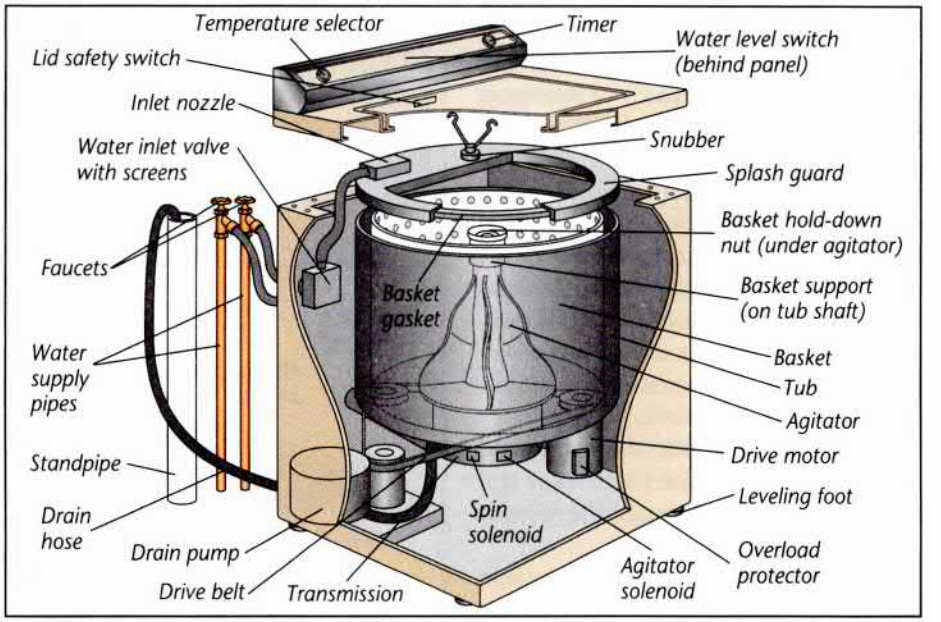
Oversudsing causes leaks and blocks drains. To reduce oversudsing when it occurs, pour 1/2 cup white vinegar mixed with some cold water into the wash.

If the water temperature isn't right, check that the faucets are fully open, screens in the inlet valve or hoses aren't clogged, and there's enough hot water.

If the washer won't spin or begins to vibrate, the wash load may be too large or out of balance. Try removing some items or redistribute the load.

CAUTION: Before making repairs, pull the plug and turn off the faucets.

Parts of a clothes washer



Troubleshooting a clothes washer

PROBLEM	POSSIBLE CAUSE	REMEDIES
Washer doesn't fill	Blocked water inlet screens	Clean or replace water inlet screens
	Defective timer or temperature selector	**Replace timer or temperature selector***
	Defective water inlet valve	**Test/replace water inlet valve***
Washer doesn't agitate	Loose or broken drive belt	Tighten or replace belt
	Defective agitator solenoid	**Replace agitator solenoid***
	Defective water level switch, timer, drive motor, or gearbox	**Test individual component and replace***
Washer doesn't spin	Clothes jammed between basket and tub	Remove basket to access clothing
	Loose or broken drive belt	Tighten or replace belt
	Defective lid safety switch, timer, or spin solenoid	**Replace switch, timer, or spin solenoid***
	Defective clutch	**Replace clutch***
Washer doesn't drain	Jammed or defective drain pump	Clear jam, or **replace pump***
	Kinked drain hose	Replace drain hose
Washer leaks	Loose or broken hoses	Tighten clamps or couplings, or replace hoses
	Defective basket gasket	**Replace gasket***
Washer vibrates excessively	Machine isn't level	Adjust leveling feet
	Defective snubber	**Repair or replace snubber***
	Loose basket or worn basket support	Tighten basket hold-down nut; **replace support***
Water doesn't shut off	Disconnected air hose	Reconnect hose (not shown) to water level switch
	Defective water inlet valve	**Test/replace water inlet valve***
	Defective water level switch	**Test/replace water level switch***
Washer fills but motor doesn't start	If motor hums, jammed drain pump or defective motor	Unjam pump; **replace motor if defective***
	Tripped or defective overload protector	Reduce load, let protector reset; **if defective replace***

***This repair is best left to a professional.** Appliance models vary; see your owner's manual for information specific to your clothes washer.*

CLOTHES DRYERS

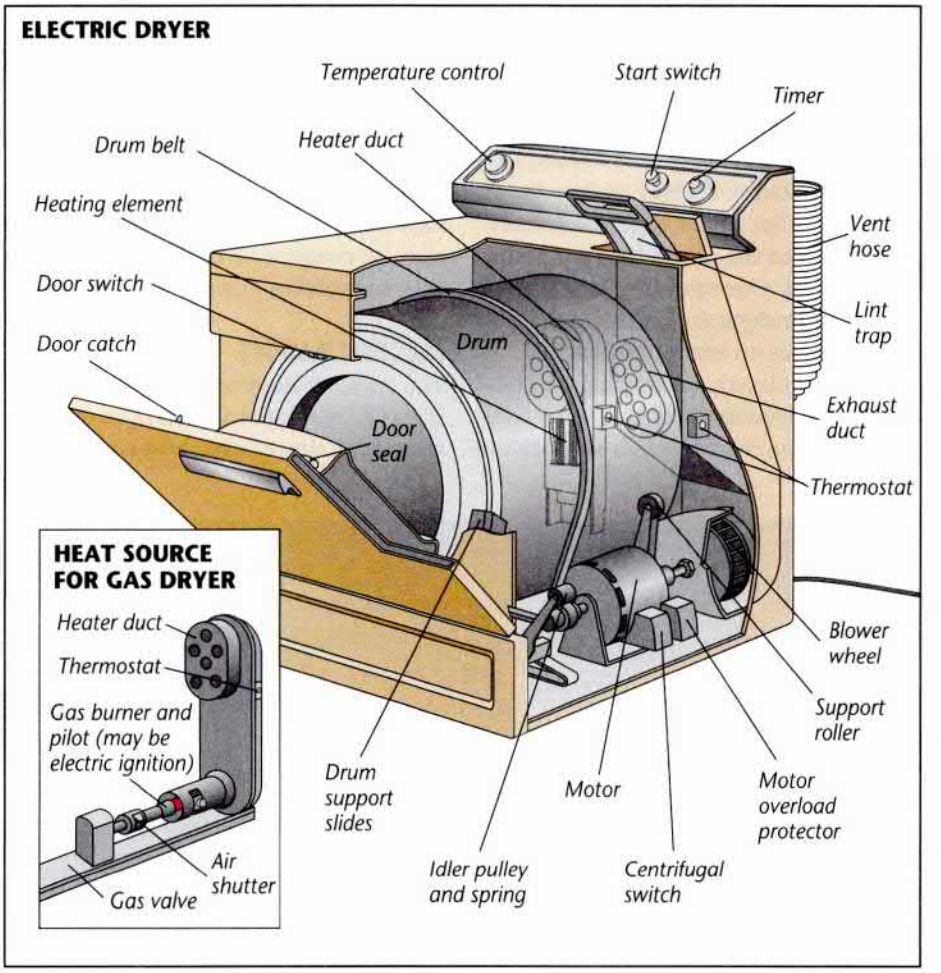
Clothes dryers are usually classified according to the kind of power that provides their heat—either electricity or gas. But even a gas dryer uses electricity for all of its nonheating functions. The parts of a standard dryer are shown at right. The inset illustrates the heat source for a gas dryer.

Whenever your dryer doesn't do its job properly, test the simple things before tackling the more complex possibilities. Is the machine's power cord defective? Has the dryer's circuit breaker tripped or fuse blown *(pages 151-152)*? When the loads dry too slowly, check the vent system first. Replace any vinyl (slinky, white) venting materials with 4-inch-diameter, rigid, metal ducting.

Clean the lint trap after every load and the vent system twice a year. If the load seems too wet to dry efficiently, the washer could be at fault. Check that the washer is spinning fast enough to extract all the water from the clothes before they are put in the dryer.

CAUTION: Before doing any repair work on your dryer, pull the electrical plug. Turn off the gas supply to a gas dryer, at either the appliance shutoff or the main shutoff valve *(page 9)*. Should you smell gas, stop what you're doing and get out of the house immediately.

Parts of a clothes dryer



Troubleshooting a clothes dryer

PROBLEM	POSSIBLE CAUSE	REMEDIES
Drum doesn't rotate, though dryer turns on	Loose or broken drum belt	Tighten loose belt; **replace broken belt***
	Loose or broken idler pulley or spring	**Replace idler pulley or spring***
	Defective support roller	**Replace support roller***
Dryer doesn't heat, though drum rotates	Defective temperature control or timer	**Replace temperature control or timer***
	Defective thermostat	**Replace thermostat***
	(E) (G) Power/gas off	Check fuse or circuit breaker/turn gas on
	(E) Defective heating element	**Replace heating element***
	(G) Defective electric ignition	**Replace ignition***
Long dry times	Clogged lint trap or exhaust duct	Clean lint trap or exhaust dust *(see text)*
	Worn door seal	Replace door seal
Dryer runs noisily	Worn drum belt	**Replace drum belt***
	Defective idler pulley or support roller	**Replace idler pulley or support roller***
	Loose blower wheel	**Secure or replace blower wheel***

(E) Electric dryer only *(G) Gas dryer only* ***This repair is best left to a professional.***
Appliance models vary; see your owner's manual for information specific to your clothes dryer.

KITCHEN RANGES

A range has electric elements or gas burners that provide heat to the cooktop and oven. Most gas ranges have electric features, including clock, lights, and electric ignition systems.

If your electric range or the electrical parts of your gas range don't work, first check the circuit breaker or fuse *(pages 151-152)*. Also, check that the connections between the power cord and terminal block on a freestanding range aren't defective. Faulty connections will result in burnt areas on the terminal block.

With an electric or gas range, a common complaint is unreliable oven temperature. The thermostat is responsible for maintaining oven temperature. If you suspect a defective thermostat, preheat your oven and bake a simple white-cake mix following the directions exactly. If the cake is unsatisfactory, call a qualified repair facility to have the thermostat checked by a professional. The thermostat is typically a very expensive part, so bear in mind that it may be possible to have it recalibrated by a technician instead of replaced.

ELECTRIC RANGES

The cooktop heating elements and baking and broiling elements of many electric ranges simply plug into a receptacle. Many newer "sealed burner" electric ranges provide for accessibility only by trained technicians. Other cooktop and bake and broil elements are accessible, but require a great deal of disassembly and wiring knowledge to repair.

If an element is not working and access can be readily obtained, check for bubbles on the element surfaces for clues to the reason for the failure. Also, make careful and simple visual inspections of wiring connections for corrosion and/or broken wires. Beyond these diagnostic suggestions, it's best to call in a professional service technician skilled with your brand name.

Troubleshooting a range

PROBLEM	POSSIBLE CAUSE	REMEDIES
Oven doesn't hold set temperature	Oven thermostat out of adjustment or defective	Recalibrate *(see text)* **or replace thermostat***
Oven "sweats"	Blocked oven exhaust vent	Remove obstruction from vent
	Worn or cracked door gasket	Replace door gasket
	Oven temperature too high	Recalibrate *(see text)* **or replace thermostat***
Uneven baking	Worn or cracked door gasket	Replace door gasket
	Range not level	Adjust leveling feet
Baked food is burned	Oven temperature too high	Recalibrate *(see text)* **or replace thermostat***
	Blocked oven exhaust vent	Remove obstruction from vent
	Pan too dark	Use bright pans
	Pans too near oven bottom	Reposition oven racks
Baked food is soggy	Oven temperature too low	Recalibrate *(see text)* **or replace thermostat***
(G) Surface burner doesn't light, or burns improperly	Gas supply shut off	Turn on gas supply
	Gas pilot light out	Relight pilot *(see owner's manual)*
	Defective electric ignition or spark module	After verifying that power is on, **replace electric ignition or spark module***
	Clogged surface burner ports	Clean burner ports with stiff wire
(G) Oven doesn't light, or burns improperly	Gas supply shut off	Turn on gas supply
	Gas pilot light out	Relight pilot *(see owner's manual)*
	Defective electric ignition or oven valve	After verifying that power is on, **replace electric ignition or oven valve***
	Clogged oven burner ports	Clean burner ports with stiff wire
(E) Surface element doesn't work	Defective element, control switch, or burner receptacle	**Test/replace component***
	Circuit breaker tripped or fuse blown	Reset circuit breaker or replace fuse
	Defective range wiring	**Replace range wiring***
(E) Bake or broil element doesn't work, or works improperly	Defective element	**Test/replace element***
	Defective oven thermostat	Recalibrate *(see text)* **or replace thermostat***
	Defective oven selector switch	**Test/replace switch***

(E) Electric range only *(G) Gas range only* ***This repair is best left to a professional.***
Appliance models vary; see your owner's manual for information specific to your range.

CAUTION: Unplug the range or turn off the power to the circuit at the service panel before making any electrical checks or repairs.

GAS RANGES

Whether on the cooktop or in the oven, a gas burner that doesn't work may lead you to a pilot light problem or an electric ignition problem. Standing pilots can simply be relit whereas electric ignition (where a spark ignites the gas) problems are a great deal more sophisticated and will generally require a service person trained for work on your brand. A gas pilot that continually goes out calls for cleaning and adjusting, and perhaps gas-company help.

The flame of a cooktop or oven burner should be a bright, steady blue. If it's not, the air/gas ratio will need to be adjusted. This repair can be dangerous, so it is best left to a professional.

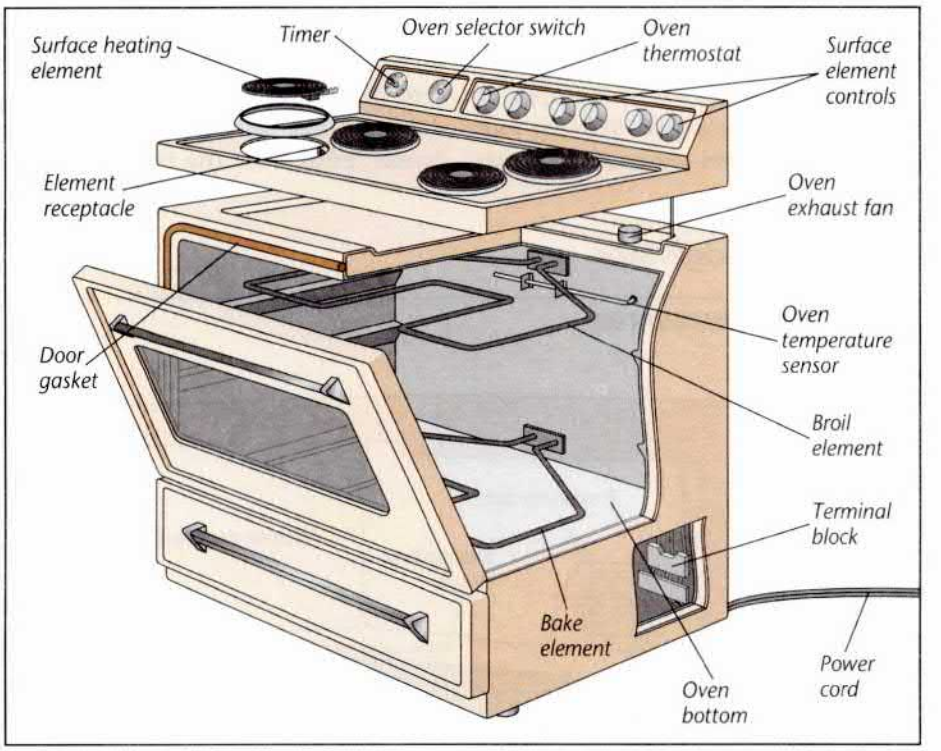
Many gas ranges, both freestanding and built-in, incorporate sophisticated circuitry (somewhat like microwave touchpads and printed circuit boards) to control oven operation. Fault codes are commonly shown in the electronic display to lead a technician to proper diagnosis and repair.

Repairs to these "electronic" gas ranges are virtually impossible for most homeowners with a limited knowledge of appliance repair. Refer to your owner's manual or call the customer relations department of the range manufacturer for information on how to proceed when you have a cooking problem or when a fault code appears. If an expensive electronic component requires replacement, don't hesitate to ask for a parts or service concession (a free part or free service) from the manufacturer of your brand, even if the appliance warranty has expired.

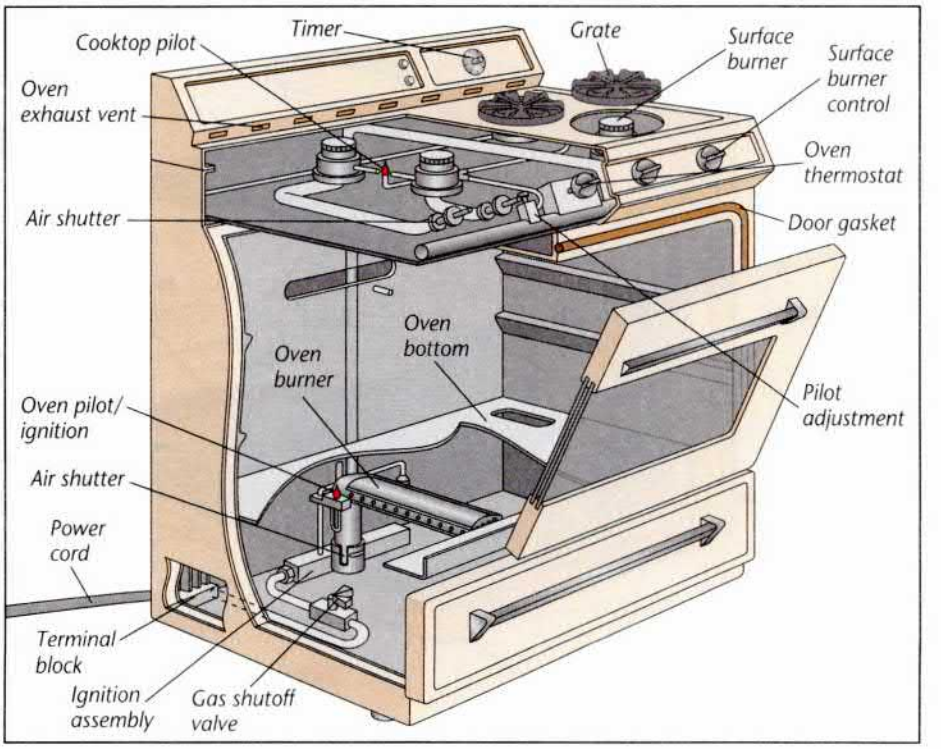
CAUTION: If you smell gas and the pilots are lit, get out of the house immediately and call the gas company from a neighbor's house.

Remember, certain features on a gas range are powered by electricity, so be sure to turn off the power if you'll be working on electrical parts.

Parts of an electric range



Parts of a gas range

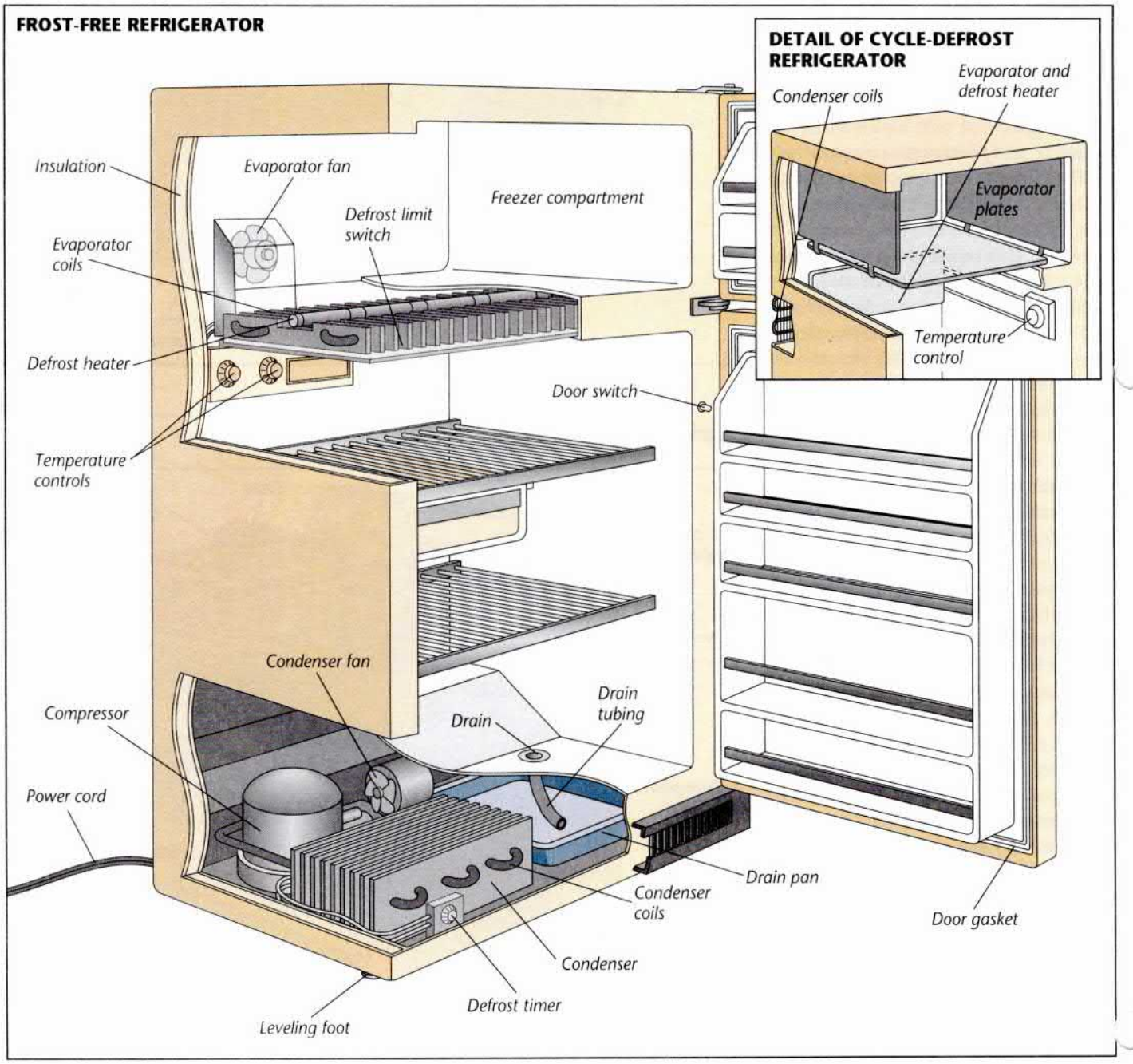


REFRIGERATORS

A few routine but faithfully accomplished preventive maintenance jobs will ensure a long and reliable life for today's frost-free refrigerator.

While there are still a number of both standard (manual defrost) and cycle-defrost (semi-automatic defrost) refrigerators in service, the overwhelming majority of units currently in use are frost-free. This means they incorporate an automatic defrost system that includes a defrost timer, a defrost limit switch, and a defrost heater. Frost from the freezer is regularly melted away by a defrost heater system. While the exact locations of these defrost components and the drain system varies with the brand of refrigerator, all the parts shown in the illustration below are located somewhere on your unit. Their location will also

Parts of a refrigerator



vary depending on whether your refrigerator is a top-freezer, side-by-side, or a bottom-freezer model.

The ideal temperature ranges for a refrigerator are minus 5 to plus 5°F for the freezer section and 36 to 38°F for the fresh-food section. If you cannot achieve these settings, try adjusting the controls and wait 24 hours for the temperatures to stabilize. If the temperatures are still not correct, refer to the chart or call a qualified repair person.

The most effective way to lengthen the life and improve the reliability of a refrigerator is to clean the condenser coils at least twice a year. Refer to your owner's manual or call your manufacturer to determine the location of the condenser and receive cleaning instructions. Also, get instructions for cleaning the defrost drain if it is required on your refrigerator. For the model shown, remove the stopper, use a pipe cleaner or similar device to push any debris through to the drain pan below, and force a solution of soap, ammonia, and water through the drain. Finally, empty the drain pan and wash it.

To ensure your refrigerator closes properly, wash the freezer and fresh-food door gaskets frequently. Apply a light coating of petroleum jelly to the leading edge of the hinge-side gaskets to prevent the gaskets from rolling inward when the doors are closed. If a gasket is cracked or torn, replace it following manufacturer's directions.

CAUTION: Before making electrical repairs, such as replacing a door switch, be sure to unplug the refrigerator. Repairs to the freon system must be performed by a certified professional.

Troubleshooting a refrigerator

PROBLEM	POSSIBLE CAUSE	REMEDIES
Refrigerator doesn't run	Power off to refrigerator	Check that refrigerator is plugged in; check for tripped circuit breaker or blown fuse *(pages 151-152)*
	Defective power cord	**Replace power cord***
	Defective temperature control	**Replace temperature control***
	Defective compressor relay and/or overload	**Test relay/overload and replace***
	Defective compressor	**Replace compressor***
Refrigerator doesn't cool properly	Dirty condenser coils	Clean condenser coils
	Defective temperature control	**Replace temperature control***
	Door doesn't seal tightly	Clean or replace door gasket *(see text)*; adjust hinges to correct sagging or warped door
	Light stays on constantly	Test by depressing door switch manually; **replace switch if defective***
	Obstructed or defective evaporator fan motor and/or blade	Remove obstruction; **if defective, replace evaporator fan motor and/or blade***
	Obstructed or defective condenser fan motor and/or blade	Remove obstruction; **if defective replace condenser fan motor and/or blade***
	Defective compressor or freon leak	**Replace compressor; check for freon leaks***
Refrigerator runs noisily	Dirty condenser	Clean condenser coils
	Refrigerator not level	Adjust leveling feet
	Loose compressor or hardened rubber compressor mounts	Tighten compressor mounts; **if defective, replace compressor mounts***
	Evaporator or condenser fan striking obstruction	Remove obstruction; **replace defective evaporator or condenser fan motor***
	Compressor tubing vibrating	Reposition tubing
	Drain pan vibrating	Reposition drain pan
Water leaks onto floor	Clogged drain	Clean drain *(see text)*
	Leak in ice-maker connection	**Tighten or replace fittings and tube***
	Cracked drain tubing or pan	Replace drain tubing or pan
Refrigerator doesn't defrost properly	Defective defrost heater, defrost timer, or defrost limit switch	**Replace defrost heater, defrost timer, or defrost limit switch***

***This repair is best left to a professional.** Appliance models vary; see your owner's manual for information specific to your refrigerator.*

The Electrical System

150 How the System Works
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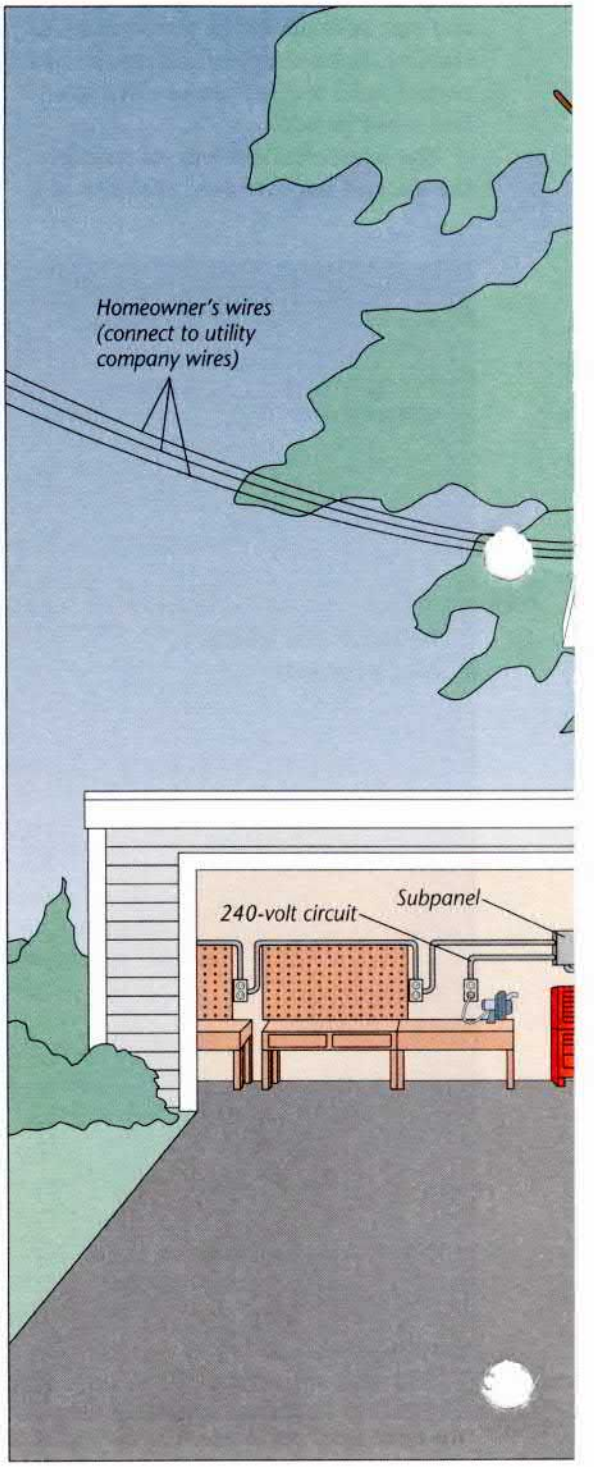
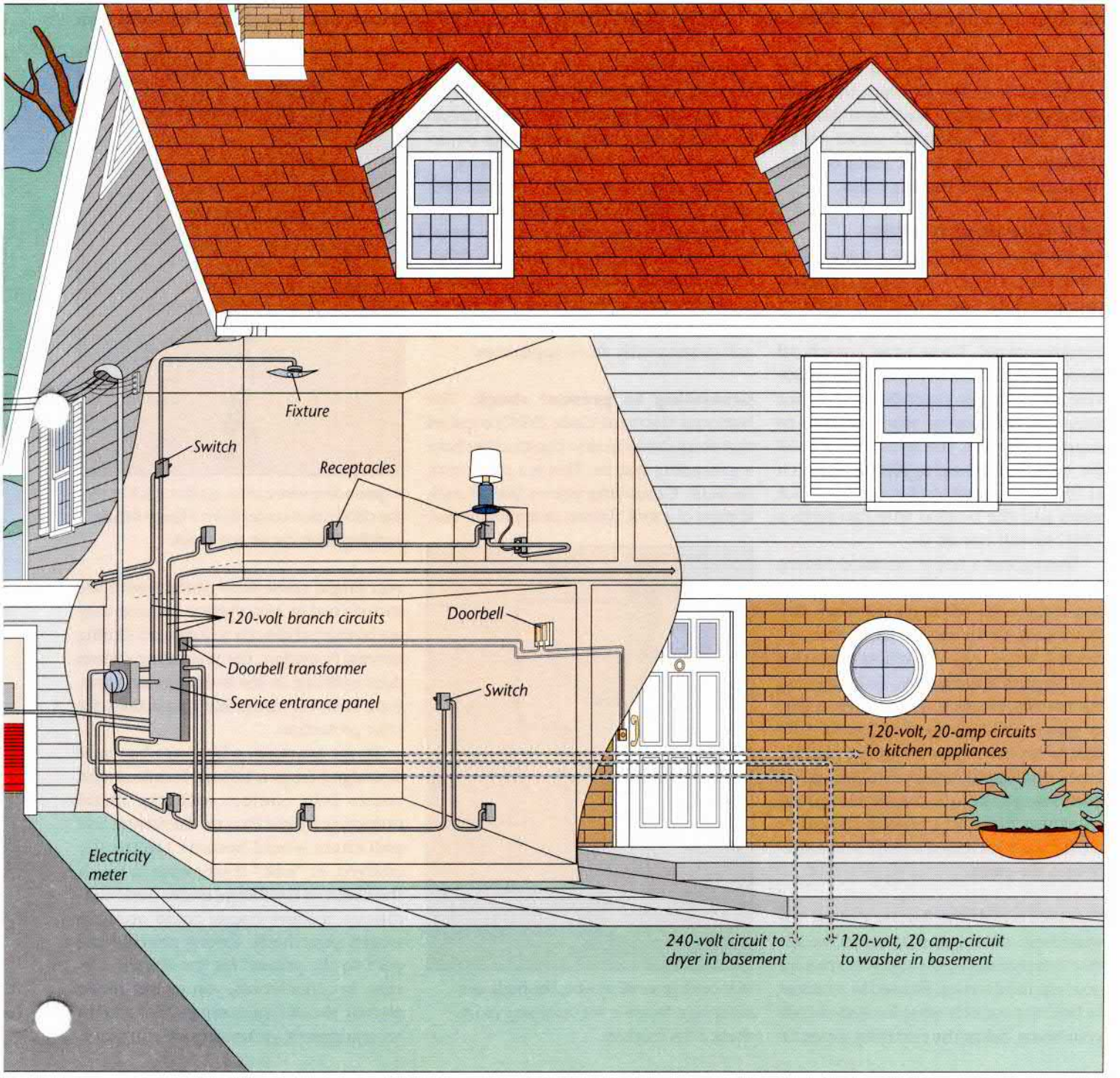
158 Wall Switches
160 Receptacles
162 Doorbells
163 Lamps
164 Incandescent Light Fixtures
166 Fluorescent Light Fixtures

Special Features

152 Shutting Off the Power
155 Working Safely with Electricity



Few of us understand electricity and the circuitry of a typical home's electrical system. But it needn't be a mystery; as the drawing below shows, a home's electrical system is made up of several kinds of interconnected components, some of which are hidden within walls and ceilings. The following chapter will examine them in detail and provide instructions for repairing and replacing such common devices as switches, receptacles, and light fixtures. Before working, be sure to read the safety information on page 155.



HOW THE SYSTEM WORKS

Electrical systems seem complex partly because they're mostly hidden within walls. But repairing a visible part of the electrical system in your home isn't necessarily complicated. With the right safety precautions *(page155)*, even novice do-it-yourselfers can replace plugs, cords, switches, and receptacles, repair light fixtures and lamps, and diagnose circuit problems when these devices break down.

Understanding the electrical system in your home will help you solve many of the problems you may encounter. So before you turn to the repair instructions on the following pages, read the information below and refer to the drawing of the electrical system on pages 148-149.

Understanding Circuitry

The word "circuit" refers to the course electric current travels, from the point where power enters your house (the service panel or subpanel wired to it) through wires to a device using electricity and back to its starting point.

HOW YOUR HOME IS WIRED

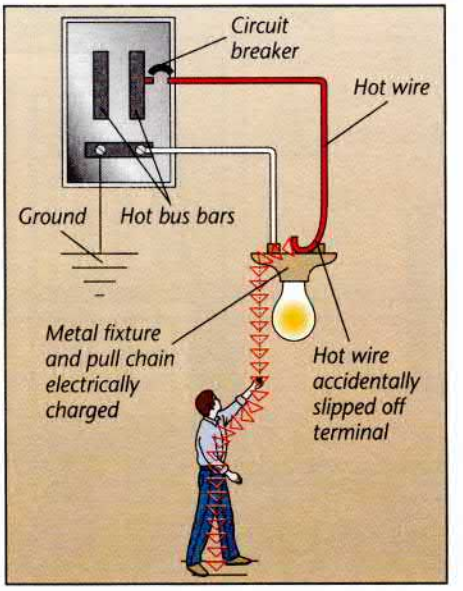
Today, most homes have what's called three-wire service. The utility company connects three wires—two "hot" and one neutral—through a meter to your service entrance panel. These wires branch off through the house to provide both 120-volt and 240-volt capabilities. One hot wire and the neutral wire combine to supply 120 volts, the level that is used for most household applications, such as lights and small appliances. Both hot wires and the neutral wire can form a 120/240-volt circuit.

Throughout a house, electrical current flows to outlets—appliances, switches, and receptacles—through hot wires, and flows back to the service panel through neutral wires. Any deviation from this normal path is dangerous. To help guard against this, electrical codes require a safety system called grounding *(see at right)* that keeps the exposed parts of fixtures, tools, and appliances at zero voltage. A grounding system incorporates special wires that divert any leaking current or dangerously increased voltage levels safely into the earth.

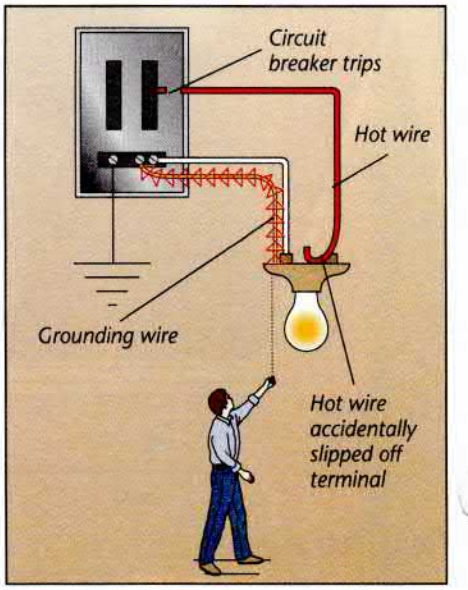
Entrance panel/distribution center. The wires from the meter connect to the service entrance panel, the control center for your electrical service. Housed in a cabinet or box, the panel is often located outside your home, below the electricity meter. Or it can be on an inside wall, directly behind the meter. In this panel, you'll usually find the main disconnect—the main circuit breakers or main fuses *(see drawings on facing page)*—to which the wires connect.

After passing through the main disconnect, the wires enter a distribution center housed in the service entrance panel or in a subpanel. Here the current is divided into branch circuits, each protected by a circuit breaker or branch fuse. The branch circuits run to lights, switches, receptacles, and permanently wired appliances.

Grounding to prevent shock. The National Electrical Code (NEC) requires that every circuit in new construction have a grounding system. This is a preventive measure. Grounding assures that all metal parts of a tool, fixture, or appliance that you might come into contact with are maintained at zero voltage because they are connected directly to a ground. During normal operating, the grounding system does nothing; in the event of a malfunction, however, the grounding is there for your protection.



Without a grounding wire, the body of a faulty light fixture is live, exposing you to shock if it is touched.



A grounding wire carries current back to the the distribution center from a faulty fixture, avoiding short circuit and shock.

If, for example, a hot wire becomes dislodged from a fixture terminal and comes into contact with the metal canopy of a light fixture, the fixture and pull chain would become electrically charged, or "hot." If you were to touch the chain or the fixture under these conditions, a short circuit could occur in which your body would provide the path to the ground for the electric current. In other words, you would get an electric shock *(see drawing at left)*. With an equipment grounding wire in place,

the electric shock would be prevented *(see drawing at left on facing page)*. A grounding wire connecting the neutral bus bar to the metal housing of the light fixture would provide an auxiliary electrical path to ground. This grounding wire would carry the fault current back to the distribution center and cause the circuit breaker or fuse protecting the circuit to trip, or open, shutting off all current flow. (Often, tools and appliances have their own ground wires to guard against shock in the event that a loose, hot wire touches the metal housing.)

In a typical house circuit, the wiring method dictates how grounding is done. When a home is wired with armored cable, metal conduit, or flexible metal conduit (in which both conduit and fittings are approved for the purpose by the local electrical code), the conductive metal enclosures can themselves form the grounding system. When metal enclosures are not used, a separate grounding wire must be run with the circuit wires.

Wire connections and polarity. Connections between wires are made inside metal or plastic boxes mounted in the walls or ceiling. Switches, receptacles, and wall- or ceiling-mounted light fixtures all have their own boxes. All boxes should be easily accessible.

Wires are wrapped in color-coded or ribbed insulation for easy identification. The purpose of color coding is to maintain proper polarity throughout the house electrical system and to every fixture or appliance connected to it. Though hot wires are usually black or red, they may be any color other than white, gray, or green. Neutral wires are white or gray. Grounding wires are bare copper or green. Occasionally in cable wiring, a white wire will be used as a hot wire; for easy identification, it should be taped or painted black close to terminals or splices.

In some cases, the identified conductor on an electrical cord is distinguished by fine ribs *(page 156)*. To ensure correct polarity, the identified conductor should always be wired to the wide prong of a polarized plug and to the socket-shell terminal of a lamp. This way, when you unscrew a lamp bulb, the threads exposed at the bulb's base are at ground potential, not hot. When incorrectly wired, the socket shell of a lamp will remain hot even when the light is switched off.

New lamps are fitted with polarized plugs. These have one narrow hot blade and one wide neutral blade. They fit a polarized receptacle only one way. Three-pronged plugs are polarized, too. When replacing a plug, always install a polarized unit (unless you live in a very old house that does not have polarized receptacles—in this case, the wider blade on the polarized plug will not fit into the receptacle).

CIRCUIT BREAKERS AND FUSES

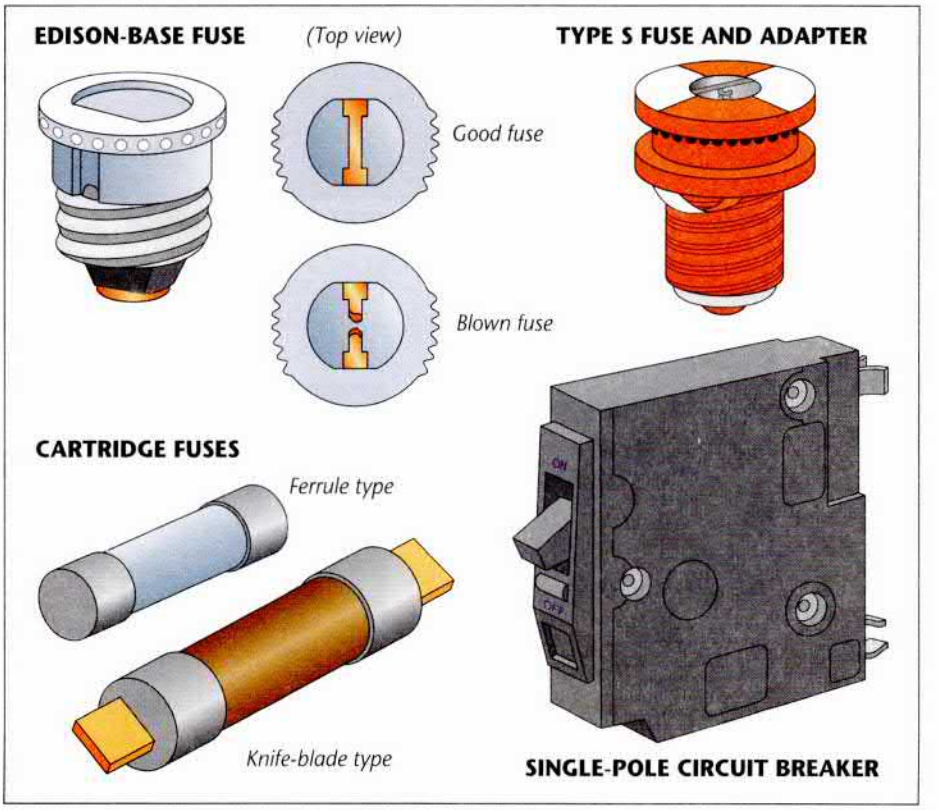
Fuses and circuit breakers, or "overcurrent protection devices," guard electrical systems from damage by too much current.

Whenever wiring is forced to carry more current than it can safely handle—usually because of too many appliances on one circuit or a problem within your system—a circuit breaker will trip or a fuse will blow, immediately shutting off the flow of current and preventing damage to the system.

Circuit breakers resemble a light switch and serve as both switch and fuse. As a switch, a circuit breaker lets you open a circuit (turn switch to OFF) whenever you want to work on the wiring. As a fuse, it provides automatic overcurrent protection.

When a breaker is installed in a circuit breaker panel, a bimetallic strip becomes the link in the circuit. Heat from excessive current will bend the metal strip, causing a release to trip and break the circuit. (The toggle goes from ON to OFF or to an intermediate position when this happens.)

A gallery of fuses and circuit breakers



...HOW THE SYSTEM WORKS

Circuit breakers can be reset (turned back on) once they've tripped (unlike fuses, which work on the self-destruct principle). All circuit breakers are rated for a specific number of amperes.

Fuses have a thin metal strip through which current passes into a circuit. If too much current starts to flow, the metal melts and cuts off the current. Fuses may be one of several types *(see illustrations on page 151)*.

Edison-base fuses. Equipped with screw-in bases like those of ordinary light bulbs, Edison-base fuses come in ratings up to 30 amps. According to the National Electrical Code (NEC), Edison-base fuses are now permitted only as replacements in 120-volt circuits. This code restriction is meant to encourage everyone to use the safer Type S fuse. Always match the fuse size to circuit rating. For example, if the circuit is rated for 15 amps, use a 15-amp fuse; never replace it with one rated higher than is proper.

Type S fuses. You must install the adapter with the correct rating in the fuse socket before using a Type S fuse. Each adapter is constructed so that it is impossible to install a fuse with a higher rating. Fuses can be replaced as needed, but once an adapter is installed, it can't be removed. Type S fuses are required in all new installations that use fuses to protect 120-volt circuits.

Cartridge fuses. There are two basic types of cartridge fuses: ferrule and knife-blade. Ferrule-type fuses, which come in ratings of 10 to 60 amps, are usually used to protect the circuit of an individual 120/240-volt appliance, such as a range. Available in ratings of 70 amps or more and suitable for 240 volts, knife-blade fuses are generally used as the main overcurrent protection in fuse-type service entrance panels.

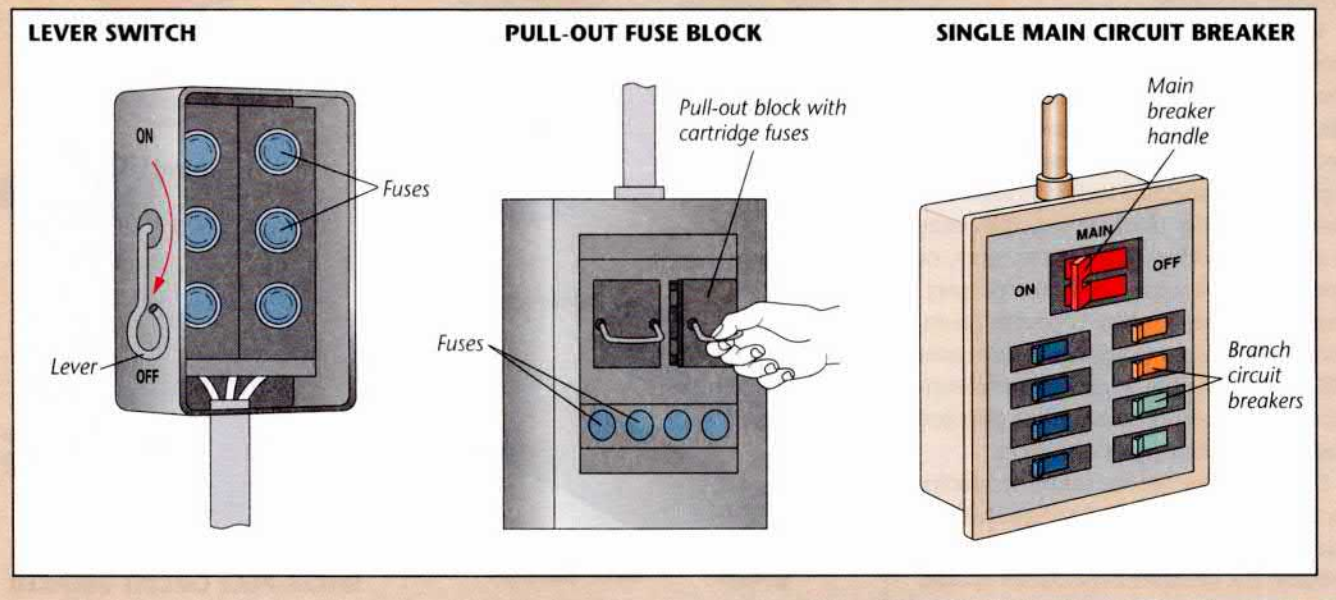
Shutting Off the Power

A main disconnect allows you to disconnect your entire electrical system, or part of it, instantly whenever you need to change a fuse or make repairs, or in case of an emergency. The disconnect will be one of the following types:

- **Lever switch.** Pull the lever to the OFF position to shut off power.
- **Pull-out fuse block.** Pull firmly on the hand grip to remove the blocks and shut off power.
- **Single main circuit breaker.** Push the main breaker handle to the OFF position to shut off power.

When you're working on a switch, receptacle, or fixture that cannot simply be unplugged, shut off power to the branch circuit. Flip the breaker for the circuit to OFF. For a circuit with a fuse, turn off the main power supply, then remove the fuse for the circuit you're working on. You can then turn on the main power supply. Then, apply backup electrical safety measures *(page 155)*.

Three types of disconnects



Diagnosing Electrical Problems

Typically, you discover you have an electrical problem when you turn on a lamp or appliance and it won't work. When that happens, the source of the problem may be the device itself, faulty wiring connections, or an overloaded or a short circuit. To determine the cause and remedy of your problem, consult the chart below.

Distinguishing between an overloaded circuit and a short circuit can be more difficult. A circuit becomes overloaded when there are more lamps and appliances on it than it can safely handle. When all the lamps and appliances on the circuit are turned on at the same time, the wiring becomes overheated, causing the circuit breaker to trip or the fuse to blow.

A short circuit occurs when a bare hot wire touches a bare neutral wire or a bare ground wire (or some other ground). The flow of extra current trips a circuit breaker or blows a fuse.

Take the steps on the facing page to determine whether you have an overloaded or short circuit.

NOTE: Plug fuses *(page 151)* provide a clue to what made them blow: an overload melts the bridge; a short circuit blackens the glass.

Troubleshooting electrical problems

PROBLEM	POSSIBLE CAUSE	REMEDIES	PAGES
Light fixture won't work (check first for burned-out bulb or fluorescent tube)	Defective fluorescent starter	Replace fluorescent starter	166-167
	Faulty switch	Replace switch	158-159
	Loose wiring	Tighten connections at switch or fixture	158-159, 164-165
	Faulty socket	Replace socket	164-165
Appliance or lamp won't work (check first for burned-out bulb or fluorescent tube)	Overloaded circuit	Test for overload; shift appliance or lamp to another circuit	154
	Damaged plug	Replace plug	156-157
	Damaged cord	Replace cord	156-157
	Loose wiring	Tighten connections at switch or receptacle	158-161
	Defect in appliance or lamp	Test in another circuit; **repair if faulty***	154
Appliance or lamp won't work in one circuit but works in others	Overloaded circuit	Test for overload; shift appliance or lamp to another circuit	154
	Loose connection at receptacle	Tighten connections at receptacle	160-161
	Short circuit	Test for short circuit; **make necessary repair***	154
Appliance or lamp won't work in one receptacle or circuit	Loose wiring	Tighten connections at receptacle	160-161
	Faulty receptacle	Replace receptacle	160-161
	Short circuit	Test for short circuit; **make necessary repair***	154
Appliance or lamp won't work in switch-controlled receptacle	Loose wiring	Tighten connections at switch or fixture	158-161
	Faulty switch	Replace switch	158-159
	Faulty receptacle	Replace receptacle	160-161
Some lights on circuit won't work	Loose wiring	Tighten connections at switch or fixture	158-159, 164-165
	Faulty switch	Replace switch	158-159
All lights on circuit won't work	Overloaded circuit	Test for overload; adjust if needed	154
	Short circuit	Test for short circuit; **repair if needed***	154
	Loose wiring	Tighten connections at switch	158-159
	Faulty switch	Replace switch	158-159

**This repair is best left to a professional.*

...HOW THE SYSTEM WORKS

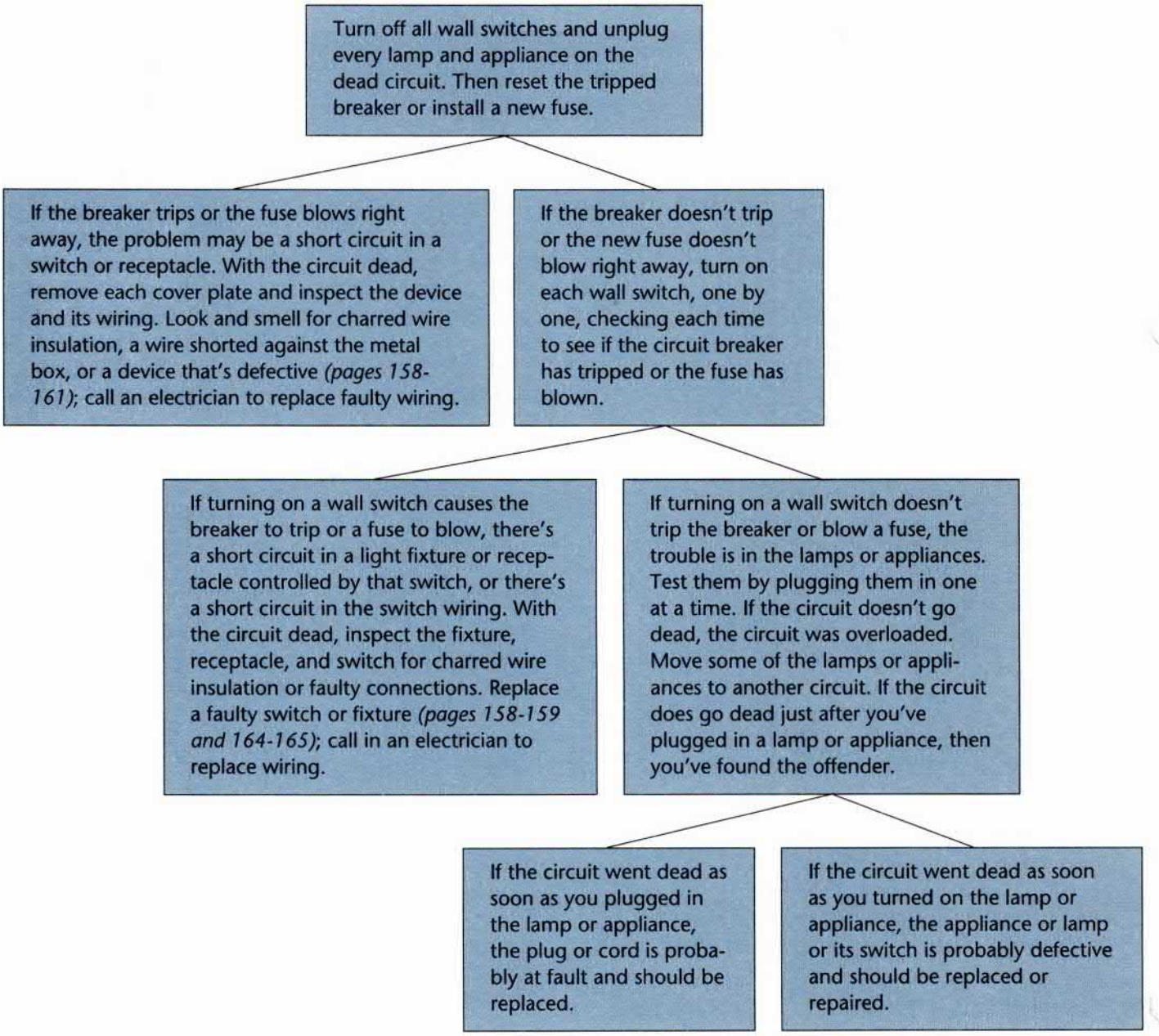
Tracing a Short Circuit or Overload

A tripped circuit breaker or blown fuse is a signal that you may have either a short circuit or an overload in the electrical system, as described on page 153.

Often, when a fuse blows or a circuit breaker trips, the cause is easy to spot. Look for black smudge marks on switch or receptacle cover plates, or for frayed or damaged cords or damaged plugs on lamps and appliances connected to the dead circuit. Replace a damaged cord or plug *(pages 156-157)*; then replace the fuse or reset the breaker.

If the circuit goes dead after an appliance has been in use for a short time, you probably have an overloaded circuit. Move some of the lamps and appliances to another circuit and replace the fuse or reset the circuit breaker for the first circuit.

If you find none of these signs of trouble, you'll have to trace your way through the circuit following the steps below. If following these steps doesn't solve the problem, and your fuse or circuit breaker still blows or trips, your wiring is faulty. Call an electrician to correct the problem.


Turn off all wall switches and unplug every lamp and appliance on the dead circuit. Then reset the tripped breaker or install a new fuse.
If the breaker trips or the fuse blows right away, the problem may be a short circuit in a switch or receptacle. With the circuit dead, remove each cover plate and inspect the device and its wiring. Look and smell for charred wire insulation, a wire shorted against the metal box, or a device that's defective (pages 158-161); call an electrician to replace faulty wiring.
If the breaker doesn't trip or the new fuse doesn't blow right away, turn on each wall switch, one by one, checking each time to see if the circuit breaker has tripped or the fuse has blown.
If turning on a wall switch causes the breaker to trip or a fuse to blow, there's a short circuit in a light fixture or receptacle controlled by that switch, or there's a short circuit in the switch wiring. With the circuit dead, inspect the fixture, receptacle, and switch for charred wire insulation or faulty connections. Replace a faulty switch or fixture (pages 158-159 and 164-165); call in an electrician to replace wiring.
If turning on a wall switch doesn't trip the breaker or blow a fuse, the trouble is in the lamps or appliances. Test them by plugging them in one at a time. If the circuit doesn't go dead, the circuit was overloaded. Move some of the lamps or appliances to another circuit. If the circuit does go dead just after you've plugged in a lamp or appliance, then you've found the offender.
If the circuit went dead as soon as you plugged in the lamp or appliance, the plug or cord is probably at fault and should be replaced.
If the circuit went dead as soon as you turned on the lamp or appliance, the appliance or lamp or its switch is probably defective and should be replaced or repaired.

Working Safely with Electricity

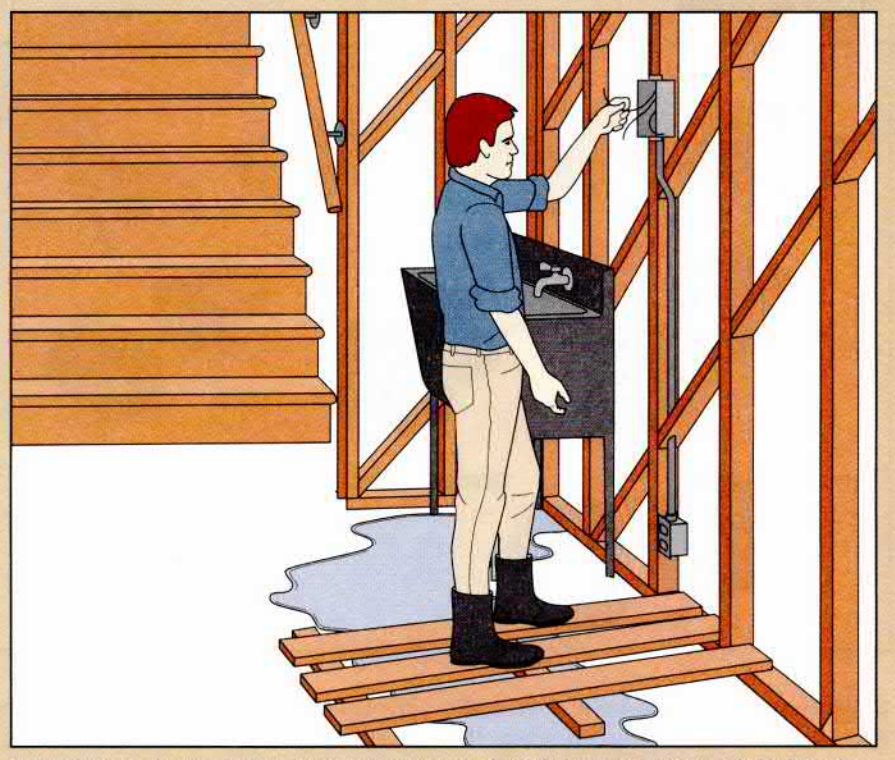
Working with electricity is one of the most dangerous activities you can undertake as a do-it-yourselfer. Unless it's handled properly, electricity can cause dangerous (even deadly) shocks and fires. Every year, novice electricians and experts alike are injured or killed when working with electricity—typically when touching live wires they thought were dead.

Codes and permits. The National Electrical Code (referred to as "NEC" or simply "the Code") is a a set of rules spelling out proper wiring methods and the materials that should be used. With safety as its purpose, the NEC forms the basis for all regulations and standards applied to electrical installations (though some cities, counties, and states have made amendments), making the book a vital addition to the library of amateur and professional electricians alike.

Cut off power flow. The most crucial point to remember when doing electrical repairs is to cut power to the appliance or circuit you're working on. Before working on your wiring, always trip the circuit breaker or unscrew the fuse to the circuit. If in doubt about which circuit to switch off, turn off the main power supply *(page 152)*. If you're working on an appliance, make sure it's unplugged.

Backup electrical safety. Once you have cut off power to the appliance or circuit you're working on, additional safety measures, sometimes referred to as backup electrical safety, should be carried out. The first step involves using a circuit tester to make sure a circuit is really dead. Sometimes two or more circuits are wired into one box. Make sure all are dead. As you begin to work, employ these additional backup safety measures.

- Use a wood or fiberglass ladder for working on ceiling fixtures (aluminum ladders conduct electricity).
- Use a cordless drill when outdoors.
- Stand on a dry board and wear rubber boots when working in damp or wet conditions *(see illustration at left below)*.
- Always use electrical tools with insulating handles. (NOTE: The handles are not intended to let you work on a live circuit.)



Standing on dry boards in rubber boots greatly reduces the danger of working in damp or wet conditions.

Fire hazards. Several faulty wiring situations can cause fires. For example, restriction of current flow through a wire or cord, as when a cord is poorly connected to its plug, may lead to overheating and fire. Replace or repair any cord or plug that shows signs of wear and tear. Teach children not to play with cords and plugs or stick any objects into the slots of receptacles; cap unused receptacles with safety covers.

Another fire hazard frequently found in homes is the "extension cord octopus," where too many appliances are plugged into an extension cord that isn't hefty enough to carry enough electricity. Excessive heat builds up in the cord as it tries to carry the load for all the appliances; the cord's insulation becomes brittle or melts from the heat; wires are exposed as the insulation deteriorates; eventually a short circuit develops, sending sparks flying when the bare wires touch each other. This situation can lead to serious shocks, as well as fires.

More safety precautions. In addition to the safety measures above, keep a few additional precautions in mind.

- Leave a note on the service panel to alert others that you are working on circuit wiring—better still, lock it.
- Study how your home is wired before you modify or work on the electrical system. The procedures described in this chapter are based on the assumption that the wiring was done correctly.
- Circuits are dead only past the points where they have been disconnected. The lines from the utility company in the service panel are still hot even after the circuit breakers have been turned off or the fuses removed.

CORDS & PLUGS

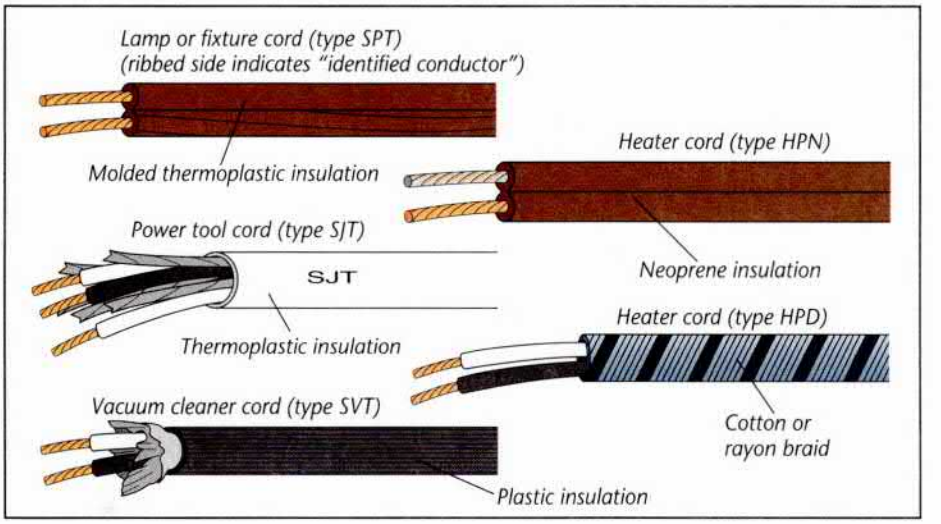
Replacing Cords

Cords on appliances and lamps are often subject to pulling and twisting that can sever the wires inside and break down the insulation, resulting in a short circuit. You should always replace (rather than repair) any electrical cord with broken wires or brittle, worn insulation.

Replacing a lamp cord *(page 163)* or a detachable female appliance cord *(see facing page)* is easy. Appliance cords that are not detachable are another matter. Unless you're familiar with the construction of the appliance, have a professional replace a faulty cord if the terminals to which it attaches are not easily accessible.

When you're buying a new cord, choose one that has the same size wires and type of insulation as the original.

Types of cords



Replacing Plugs

Any plug with a cracked shell or loose, damaged, or badly bent contacts should be replaced. Also replace plugs that transmit power erratically or get warm when used. If a plug arcs when it's pushed into or pulled out of a receptacle, examine the wires; if they're not firmly attached to the terminal screws, tighten the connections.

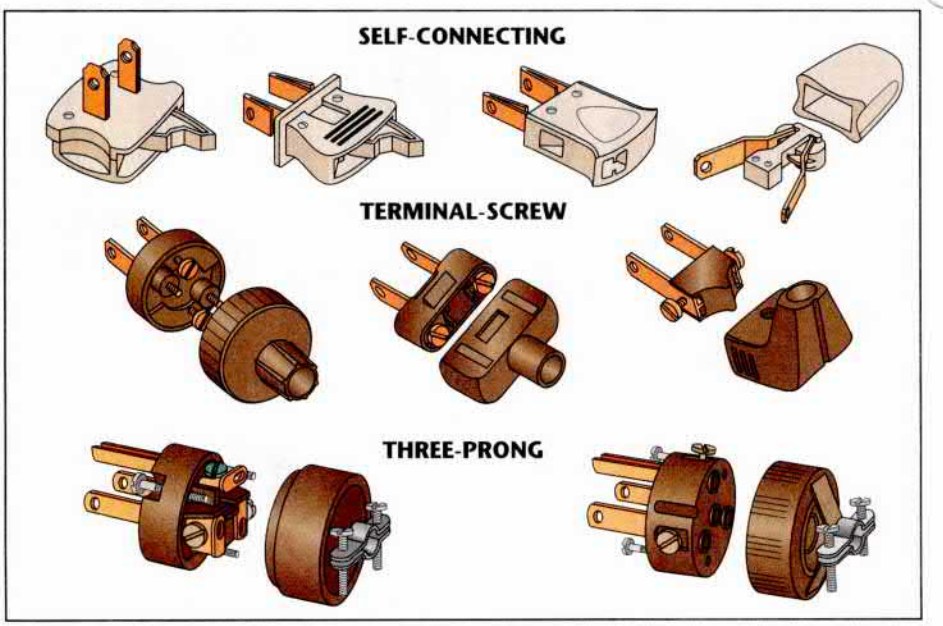
The two kinds of common plugs are terminal-screw and self-connecting. In plugs with terminal screws, the wires are attached to screws inside the plug body. Self-connecting plugs clamp onto wires, making an automatic connection. These plugs, as well as two-prong plugs with terminal screws, are commonly used for lamps and small appliances. Three-prong grounding plugs are used for larger appliances and power tools. Detachable cords for small appliances have female plugs with terminal screws.

NOTE: Many old-style plugs with terminal screws have a removable insulating disc covering the terminals and wires. The NEC now requires "dead-front" plugs; such plugs have a rigid insulating barrier.

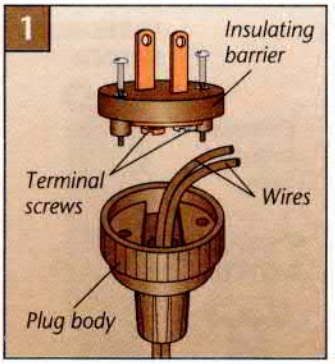
To replace a plug, cut off the old one plus at least an inch of the cord. For plugs that have terminal screws, split the cord insulation to separate the wires; then strip the insulation from the ends *(page 159)*.

When replacing a two-prong plug, connect the identified conductor to the silver-colored screw. For a three-prong grounding plug, attach the wires to the terminal screws as follows: white neutral wire to silver screw, black hot wire to brass screw, and green grounding wire to green terminal screw.

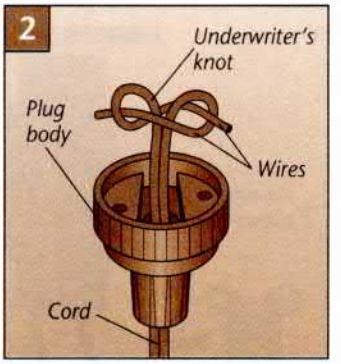
Types of plugs



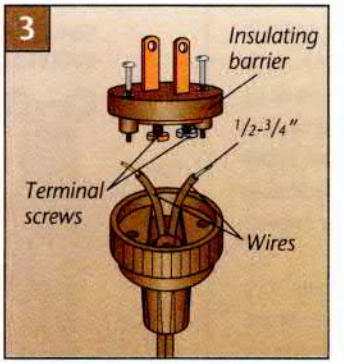
Replacing a plug with terminal screws



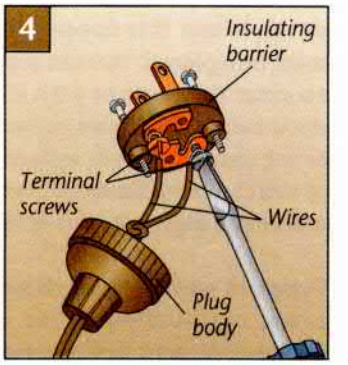
Unscrew and remove the new plug's insulating barrier. Using a utility knife, split the end of the cord to separate the wires; push the cord through the plug body.



Make two loops with the wires, pass the loose ends of the wires through the loops, and pull to form an Underwriter's knot (to prevent strain on connections).

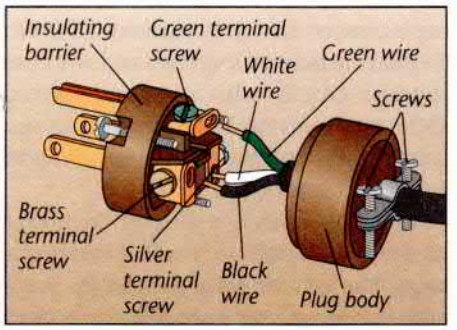


Strip 1/2 to 3/4 inch of insulation off the wire ends, being careful not to nick the wires *(page 159)*. Unscrew the terminal screws to allow space for the wires.

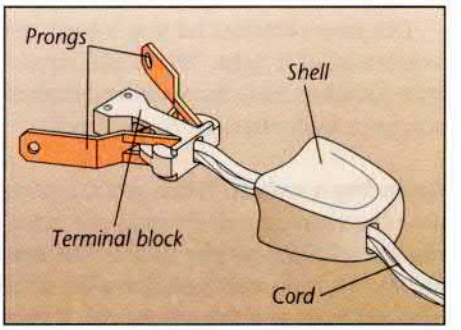


Form loops on wires and wrap them clockwise three-quarters of the way around screws. Tighten the screws, trim excess wire, and reattach the barrier to the body.

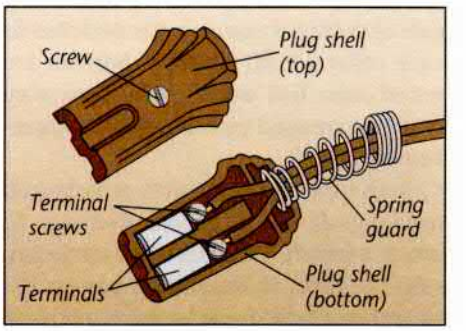
Replacing three special types of plugs



Three-prong grounding plug. Unscrew the insulating barrier; push stripped wires through the plug body into the correct terminal slots. Tighten the terminal screws and reassemble the plug.



Self-connecting plug. Push the cord (don't strip it) through the shell and into the terminal block; squeeze the prongs together to grip the cord and slide into the shell.



Female appliance plug. Unscrew the plug shell; feed the cord through the spring guard. Strip the wire ends *(page 159)*, wrap them clockwise around the terminal screws, and tighten; reassemble the plug.

Replacing 240-volt Appliance Cords

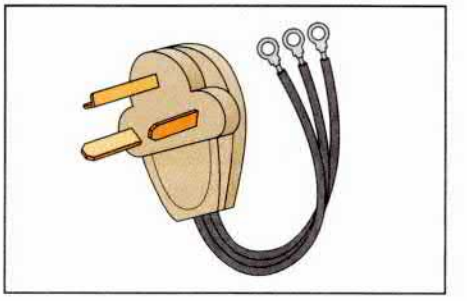
Replacing cords and plugs on 240-volt appliances is simple if the terminals are easily accessible; use a new pigtail cord with a plug molded to it *(see at right)*.

To replace the old cord and plug, unplug the cord and unscrew the other end from the terminal screws on the appliance. Be sure you get an exact replacement for the damaged cord and plug.

Connect the new pigtail cord to the terminal screws on the appliance. If the wires in the cord and the screws on the appliance are color-coded, attach the wires to the terminal screws of the same color (typically, black to black, white to white, red to red).

If the pigtail cord or the appliance terminal screws are not color-coded, first attach the center wire of the pigtail to the center terminal screw on the appliance. Then connect the remaining wires to the terminal screws. Plug in the new cord.

Pigtail cord



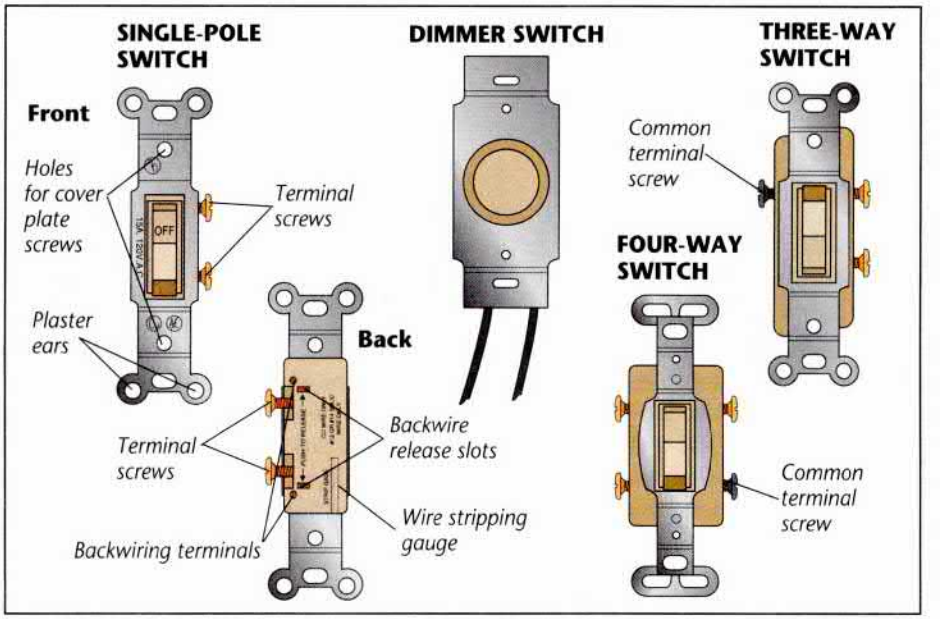
WALL SWITCHES

When a switch fails, it's usually because the contact points are worn or have oxidized. When this happens, the switch must be replaced. You can replace it with an exact duplicate or with a dimmer or silent switch. Directions below and on the facing page tell how to replace most types of switches and dimmers. Silent switches are simply quiet versions of these types.

Types of switches. Most switches in a home are single-pole or three-way. Single-pole switches control a light or receptacle from one location only and have two screws of the same color. Three-way switches operate in pairs to control a light or receptacle from two locations. They have two screws of the same color, either brass or silver, and one—called the common terminal screw—of another color, either copper or black. (The brass or silver screws of a pair of switches connect the switches to each other.) Both types of switches are wired into hot wires only. Four-way switches are used between pairs of three-way switches.

Both types may have a set of backwired terminals as well as terminal screws. To attach a switch with backwired terminals, strip the wires (a stripping gauge on the back shows how much to strip) and push the ends into the holes *(see facing page)*.

Types of switches

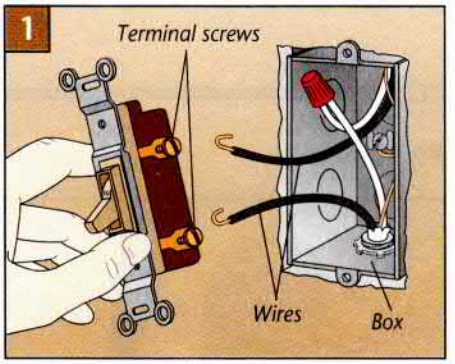


Dimmer switches let you adjust the brightness of a light. Wired like single-pole switches, they have either terminal screws or lead wires *(see facing page)*.

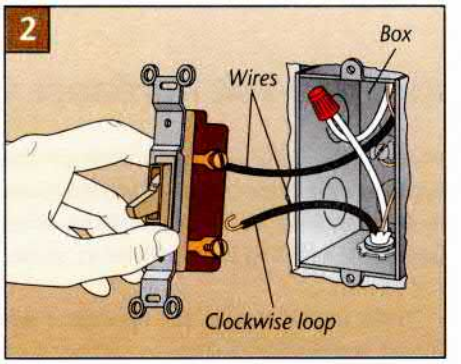
Replacing a switch. When you're buying a replacement, carefully read the information stamped on the back of the new switch; the new one should have the same amp and voltage ratings as the old. If your home's wiring is aluminum, use only replacement switches marked CO/ALR. Replace unmarked switches and switches marked CU/AL with switches marked CO/ALR. Don't backwire switches to aluminum wiring; attach aluminum wires to terminal screws only.

CAUTION: Always shut off the power to the circuit *(page 152)* before you begin work. Use a circuit tester *(page 22)* to make sure the circuit you're working on is dead before you touch any wires or terminals.

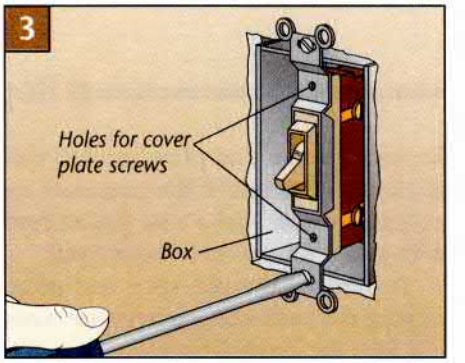
Replacing a single-pole switch



Turn off power to the circuit, remove the switch cover plate, and test to make sure power is off. Unscrew the switch and pull it out carefully. Unfasten the wires.

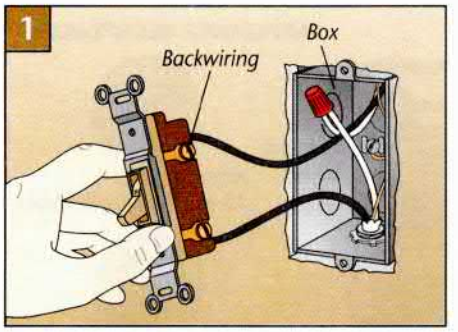


To attach the new switch, loop the stripped wire ends clockwise around the terminal screws on the switch. Tighten the terminal screws with a screwdriver.

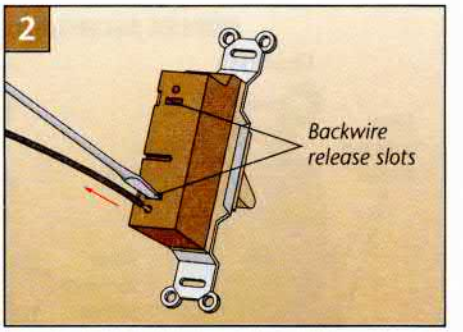


Push the switch carefully into the switch box to avoid crimping the wires. Screw the switch to the box. Finally, screw the cover plate into place.

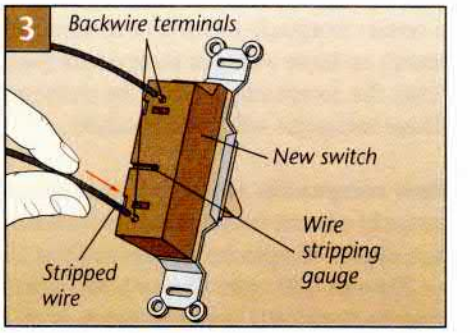
Replacing a backwired single-pole switch



To replace a backwired switch, shut off the power, unscrew and remove the cover plate, and test to make sure power is off. Unscrew and remove the switch from the box.



Push a small-bladed screwdriver into the backwire release slot on the back of the switch next to each wire; pull the wires out.



Push stripped wire ends (measure using the wire stripping gauge) into the terminal on the new switch. Attach the switch to the box; replace the cover plate.

PROFESSIONAL TIPS

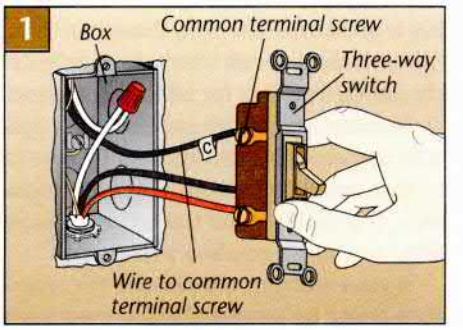
STRIPPING WIRE

For the vast majority of simple electrical repairs, you can use a utility knife or penknife to strip insulation off the ends of wires. First, use the knife blade to score through the insulation all the way around; then, simply pull the insulation off the wire.

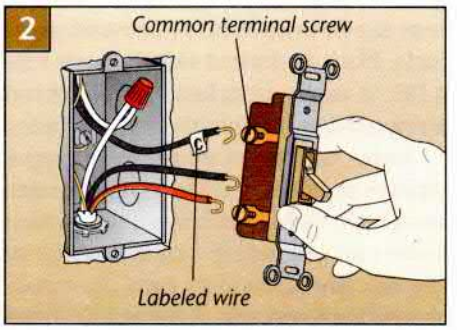
Be careful not to nick the wire when you cut; a nicked wire has reduced current-carrying capacity and breaks more easily when bent to form a loop for a connection to a terminal screw. If you do nick the wire, it's a good idea to cut the wire back at least to the nick and strip away another section of insulation.

If you need to make a large number of electrical repairs, you can purchase a special wire stripper, an inexpensive tool that adjusts for different wire sizes, or a more expensive electrician's multipurpose tool that performs other electrical jobs as well. These tools, illustrated on page 22, easily remove insulation without ever cutting or nicking the wire.

Replacing a three-way switch

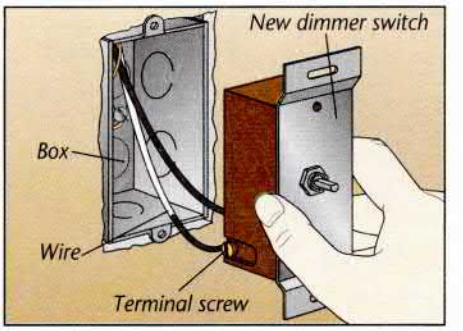


Remove the cover plate (after shutting off the power). Unscrew and pull out the old switch. Label the wire to the common terminal screw with tape.

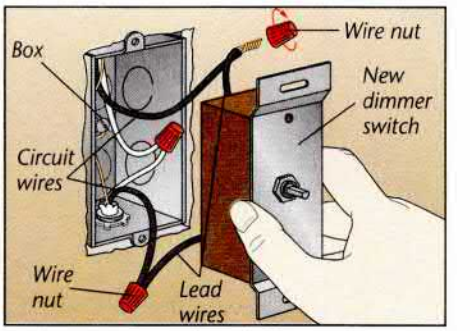


Attach the labeled wire to the common terminal screw (black or copper) of the new switch. Connect each remaining wire. Insert in the box and fasten.

Installing two types of dimmers



Dimmer with terminal screws. Shut off the power; remove the old switch. Loop the circuit wires clockwise around the terminal screws on the dimmer; insert in the box.



Dimmer with lead wires. Shut off the power; remove the old switch. Connect the circuit wires to the dimmer's lead wires. Screw on wire nuts; insert the box.

RECEPTACLES

If appliances or lamps that work properly elsewhere won't work when plugged into a certain receptacle and you've determined there's no loose wiring or short circuit *(page 154)*, the receptacle needs to be replaced. These two pages will show you how.

How receptacles are wired. Most receptacles in a house have two outlets (known as a duplex receptacle) and are rated at 15 or 20 amps, 120 volts. One or both outlets may be electrically live at all times, or one or both may be controlled by a wall switch. The receptacle may be installed in the middle or at the end of a circuit (the wiring arrangement varies accordingly).

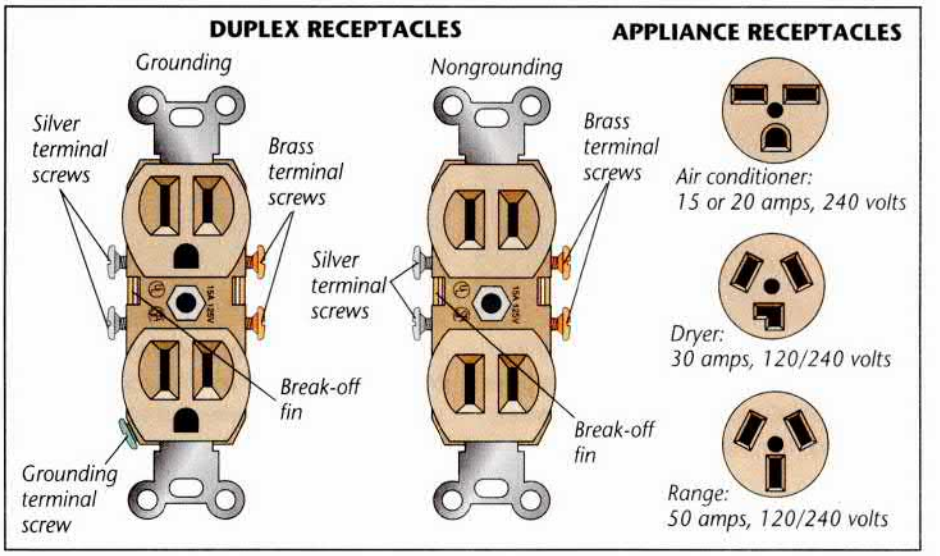
Receptacles have three different colored terminal screws. Brass screws are hot, white or silver screws are neutral, and green ones are for grounding. A receptacle may also be backwired. A backwired receptacle, like a backwired switch *(pages 158-159)*, is easily installed: Simply insert stripped wire ends into the terminal holes.

Newer receptacles are grounding types. Always replace an older nongrounded receptacle with a grounding type unless there's no grounding wire in the box or the box isn't grounded; then use a nongrounding receptacle. A grounding receptacle installed in an ungrounded box must be grounded independently; for help, consult an electrician. If no means of grounding is present in the box, though, a GFCI (ground-fault circuit interrupter) receptacle can be installed for added protection.

Because receptacles are rated for a specific ampere flow and voltage, be sure to replace an old one with an exact duplicate. If possible, take the old receptacle with you when you buy a new one.

If your wiring is aluminum, the receptacle must be designed to be used with aluminum wire (look for the letters CO-ALR). Use the terminal screws only; backwiring is not suitable for aluminum wires.

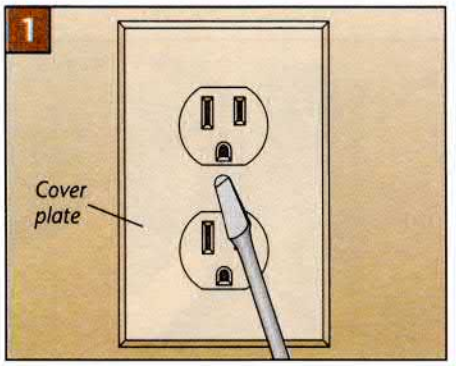
Types of receptacles



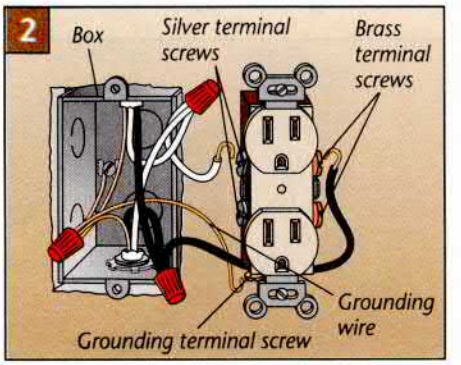
Replacing appliance receptacles. These receptacles, rated from 15 to 50 amps, 240 volts, and from 20 to 50 amps, 120/240 volts, each require a special plug that will fit only that receptacle. Take care when working; these units have two hot wires—usually red and black—going to them. They may have a separate grounding wire.

CAUTION: Before working, turn off power to the circuit *(page 152)*. For a 240-volt circuit, you must remove two fuses, a fuse block, or trip a circuit breaker.

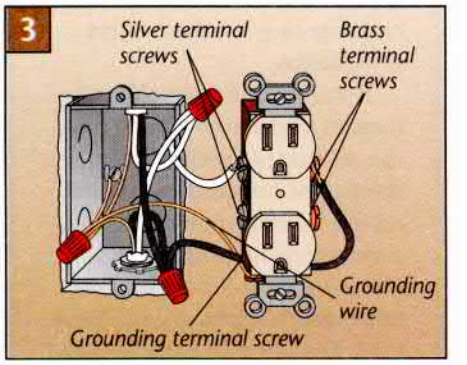
Replacing a grounding receptacle (middle of circuit)



To remove a faulty receptacle, first shut off power to the circuit and test to make sure it's off. Then unscrew the cover plate, remove it, and set it aside.

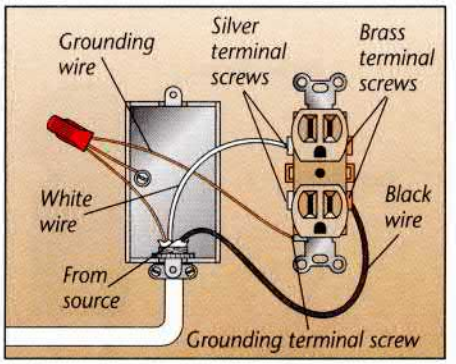


Unscrew the receptacle from its box and carefully pull it out. Note which wire is connected to which terminal screw; then disconnect the wires from the screws.

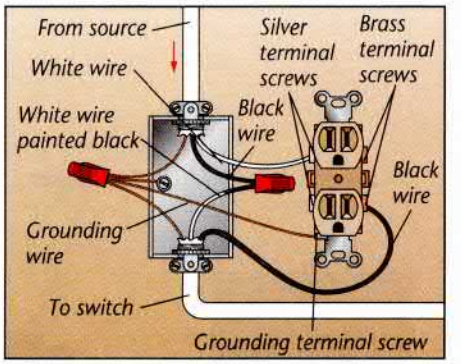


To install the new receptacle, wrap the wires clockwise around the screws (use the old receptacle as a guide). Screw the receptacle to the box. Replace the cover plate.

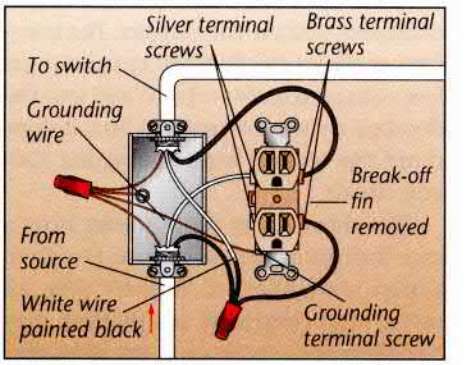
Replacing three specially-wired receptacles



Receptacle at the end of a circuit. Attach three wires as shown: black (hot), white (neutral), bare or green (grounding).

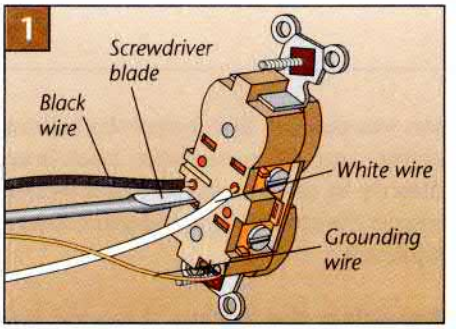


Switch-controlled receptacle. Attach as shown; note the white wire (painted black) is sometimes connected to the black wire.

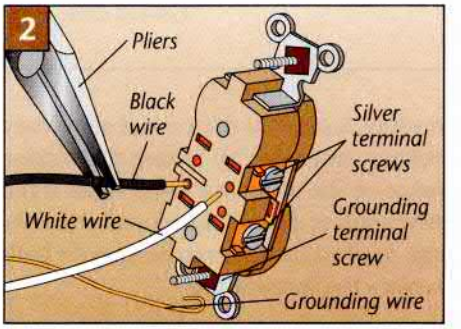


Half of receptacle is switch-controlled (other half is always live). Label wires and screws carefully; rewire.

Replacing a backwired receptacle

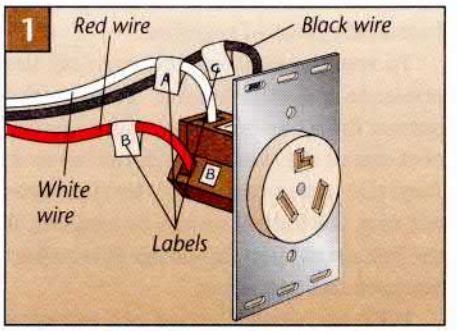


To remove the receptacle, shut off the power and test to make sure it's off. Push a small-bladed screwdriver into the slots next to the wires; pull them out.

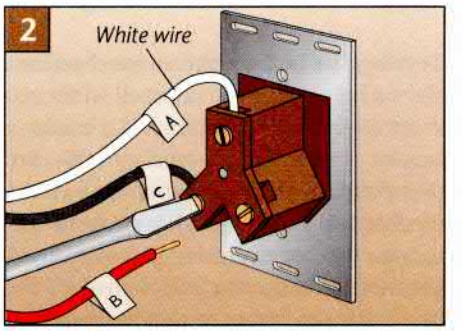


To install the new receptacle, push the black wire's stripped end into the hole by the brass screws, the white wire into the hole by the silver ones.

Replacing a 120/240-volt receptacle



To remove a 120/240-volt receptacle, shut off the power. Remove the receptacle from its box and label the wires and screws; detach the wires.



Reconnect the wires to their proper screws on the new receptacle. Reattach the receptacle to the box; replace the cover plate.

PROFESSIONAL TIPS
USING WIRE NUTS

For most simple repairs, you won't need to splice wires. But you may have to splice two or more copper wires to replace a damaged wall or ceiling light fixture, or to make a connection in a receptacle, switch, or junction box.

Turn off the power to the circuit *(page 152)* before you begin making any splice and test to make sure it's off. To splice wires, first strip 1 inch of insulation off the wire ends, twist the wires together clockwise with pliers, and snip 1/4 to 3/8 inch off the ends. Next, cap the twisted strands with a wire nut, turning it clockwise to ensure the new connection is secure (tug on the wires to check). Make certain the wire nut is the proper size for the wires being joined.

CAUTION: Do not use wire nuts to splice together a damaged extension cord. As a safety precaution, the NEC allows you to splice house wires only within accessible junction, receptacle, fixture, or switch boxes.

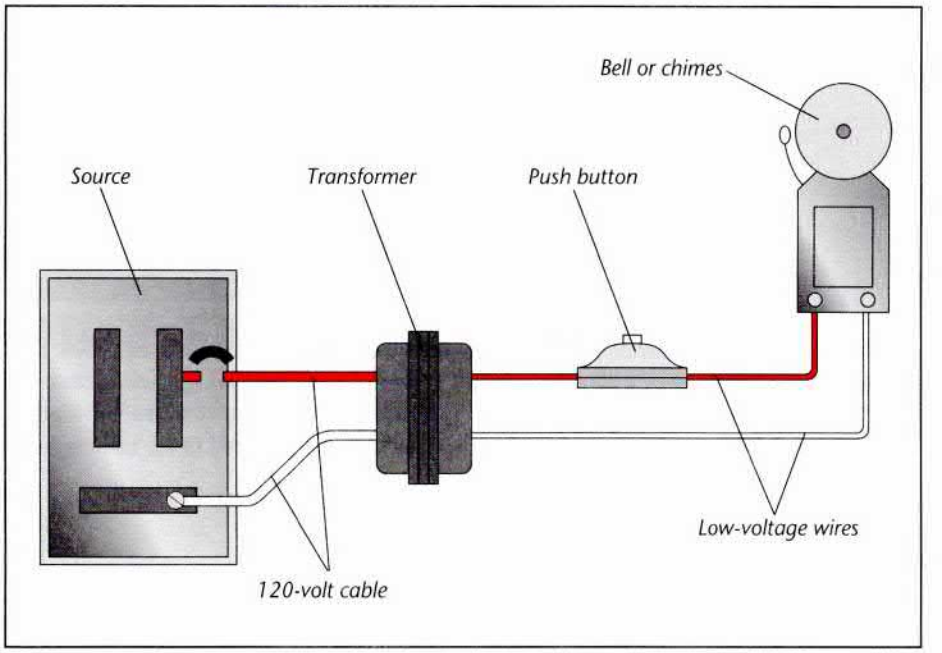
DOORBELLS

The parts of a typical doorbell system are the push button, the door bell (or chimes or buzzer), and the transformer. The transformer allows the doorbell to operate on low voltage (6 to 24 volts). Wired into the doorbell circuit at a junction box, it steps down the voltage from the regular 120-volt circuit.

The drawing at right shows how a one-button doorbell system is wired. When your doorbell doesn't ring, or worse, rings constantly, the problem may lie in one of the parts or in the wires that connect them.

NOTE: To diagnose most doorbell problems, you'll need to have the power source connected. But if you're going to work on the transformer or the wires in the junction box, be sure to shut off the power to the circuit and test to be sure it's off. (Remember that the input side of the transformer is high voltage—120 volts.)

A typical doorbell system



A SILENT DOORBELL

One of a variety of problems—a faulty transformer, push button, or bell, dirt in the mechanism, or poor wiring—can cause your doorbell not to sound. The first place to look is at the source of power. Make sure a circuit breaker hasn't tripped or fuse hasn't blown *(pages 151-152)*. Once you're certain that the 120-volt side of the transformer is getting power, shut off the power and tighten all wire connections. Then turn the power back on and check the low voltage side, following the steps below to find the source of the trouble.

Testing the transformer. The best and safest way to test whether the transformer is functioning properly is to use a volt-ohm meter *(page 22)*. If the transformer is working correctly, the meter reading should match the secondary voltage (6 to 24 volts) marked on the transformer or bell.

Set the voltage range on the meter to 120 volts AC and measure the voltage between the two low-voltage terminals on the transformer. If the meter reads significantly higher than the correct secondary voltage, the transformer is defective and should be replaced. If the reading is close to the correct secondary voltage, test again by setting the voltage range on the meter to a lower value. If the new reading doesn't agree with the voltage marked on the transformer or bell, replace the transformer.

Testing the push button. To check the button, disconnect the two wires connected to it and short them by touching their bare ends together. If this makes the bell ring, the push button is defective and should be replaced. If the bell doesn't ring, the problem is either in the bell or chime mechanism itself or in the wiring.

Testing the bell or chime mechanism. Have a helper ring the doorbell while you listen to the bell (or chime). If it hums or buzzes, it may be gummed up with dirt. (For example, the striker shaft on a chime mechanism can get stuck because of corrosion, dirt, or excessive grease.) Check the mechanism and clean if needed. Use fine-grade sandpaper to remove corrosion from any contacts.

If the bell (or chime) still hums or buzzes after cleaning, replace it. If it did not make any noise at all when the button was pushed, disconnect the bell (or chime) and, using new wire, hook it up directly to the transformer. If it works, inspect the old wiring. If it doesn't sound, replace it.

Repairing the wiring. Examine the wiring for breaks or frayed insulation that may be causing the wires to short out. Repair any breaks and wrap the repairs with electrician's tape.

A CONSTANTLY RINGING DOORBELL

If a doorbell rings constantly, either the button is stuck or the wires going to the button are shorted together.

To test the button, first turn off the power to the transformer. Remove the button from the door frame and disconnect one of the two wires connected to it. Turn the power back on. If the bell does not ring, the button should be replaced. If the bell rings, then the problem is a short between the two wires.

With the power turned off, examine the wires for frayed insulation or bare wires touching; use electrician's tape to wrap them where necessary. If you can't find the short, replace the wires.

LAMPS

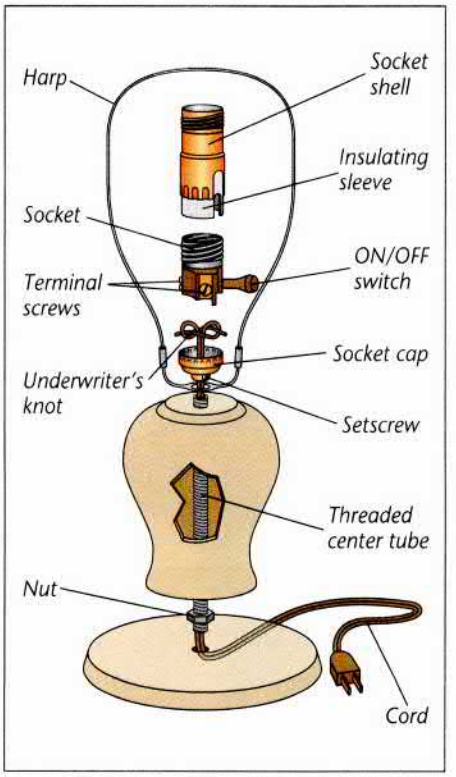
Most plug-in incandescent lamps have a socket, switch, cord, and plug. (In a simple lamp like the one shown at right, the switch is built into the socket.) Any one of these parts may wear out and need to be replaced.

To check a lamp that doesn't work, first test the light bulb. Next, plug the lamp into another receptacle to be sure the receptacle isn't at fault. Check the plug and cord for wear. To replace the plug, see pages 156-157; to inspect and replace the cord, see at right. If the bulb, cord, and plug are in good shape, use a continuity tester *(page 22)* to test the socket. To replace the socket and built-in switch, see at right. (If the lamp's switch is attached to the cord, check it and replace if faulty.)

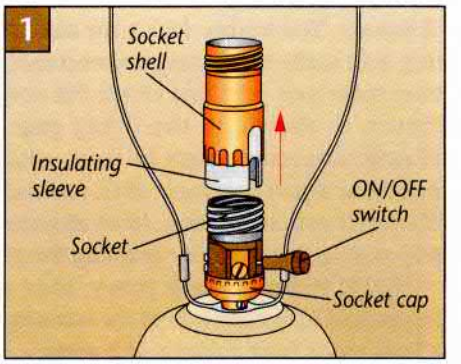
A lamp assembled with rivets instead of nuts and bolts can't be taken apart for repair, so you'll have to replace it.

CAUTION: Before working on any lamp, make sure it's unplugged.

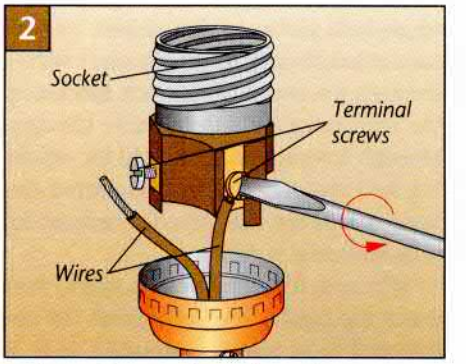
Parts of a lamp



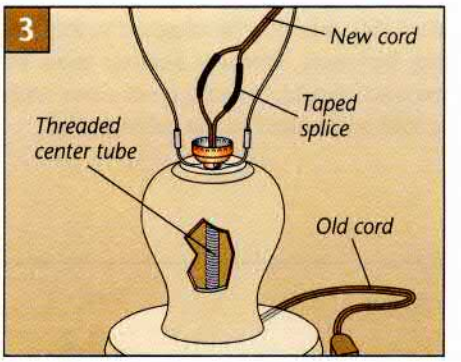
Replacing a lamp socket and cord



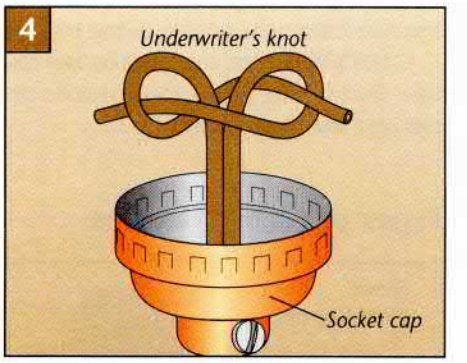
To remove the socket, first loosen the socket shell by pushing in on the area where the word PRESS is embossed. Lift off the shell and insulating sleeve.



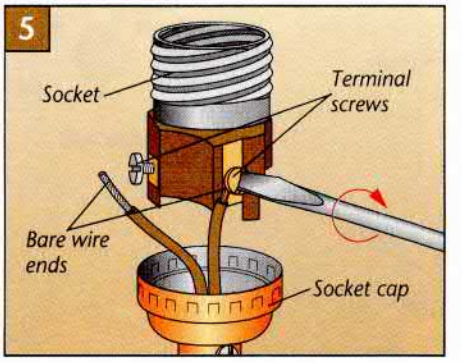
Unfasten the wires from the socket terminal screws; inspect the cord insulation. If it's okay, test the socket and replace if necessary; if it's faulty, go to Step 3.



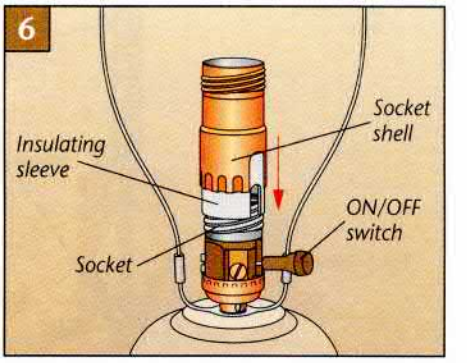
To replace a faulty cord, untie the knot. Splice the new cord to the old by twisting the wires' bare ends together and taping them. Pull both cords through; detach the old cord.



Split the new cord to 2 1/2 inches from the end. Tie an Underwriter's knot by making two loops and passing the loose wire ends through the loops. Pull the knot snug.



Wire the identified conductor *(pages 150-151)* to the terminal screw serving the shell of the socket (double-check with a continuity tester). Wire other screw; tighten screws.



Push the insulating sleeve over the socket; then push in the shell until you hear it click. Attach a polarized plug to the cord; maintain correct polarity *(pages 150-151)*.

INCANDESCENT LIGHT FIXTURES

Incandescent fixtures include many styles of wall- and ceiling-mounted lights—from single-bulb globes to chandeliers. They're connected directly to your home's wiring through a recessed ceiling box hidden by the fixture or by a decorative canopy. Though instructions here are for repairing and replacing ceiling-mounted fixtures, you'll use the same procedures for wall-mounted styles.

When a fixture doesn't work, first check the light bulb. Then check the circuit and light switch *(pages153-154)*. If the fixture is the problem, the cause may be in the wiring or the socket. Detach the fixture from the ceiling box and check for a loose connection. Tighten it if necessary. If the fixture still doesn't work, you'll have to either replace or repair it as described here and on the facing page.

CAUTION: Before you work on any fixture, shut off the power to the entire circuit and test that it's off.

Replacing a fixture. The replacement procedure is basically the same for all types of fixtures. You simply detach the old fixture and undo the wiring connections, then make new ones and attach the new fixture, as shown on the facing page. Wiring connections may be made with wire nuts; if there are more than just two black and two white wires, label all wires and make a sketch before undoing them.

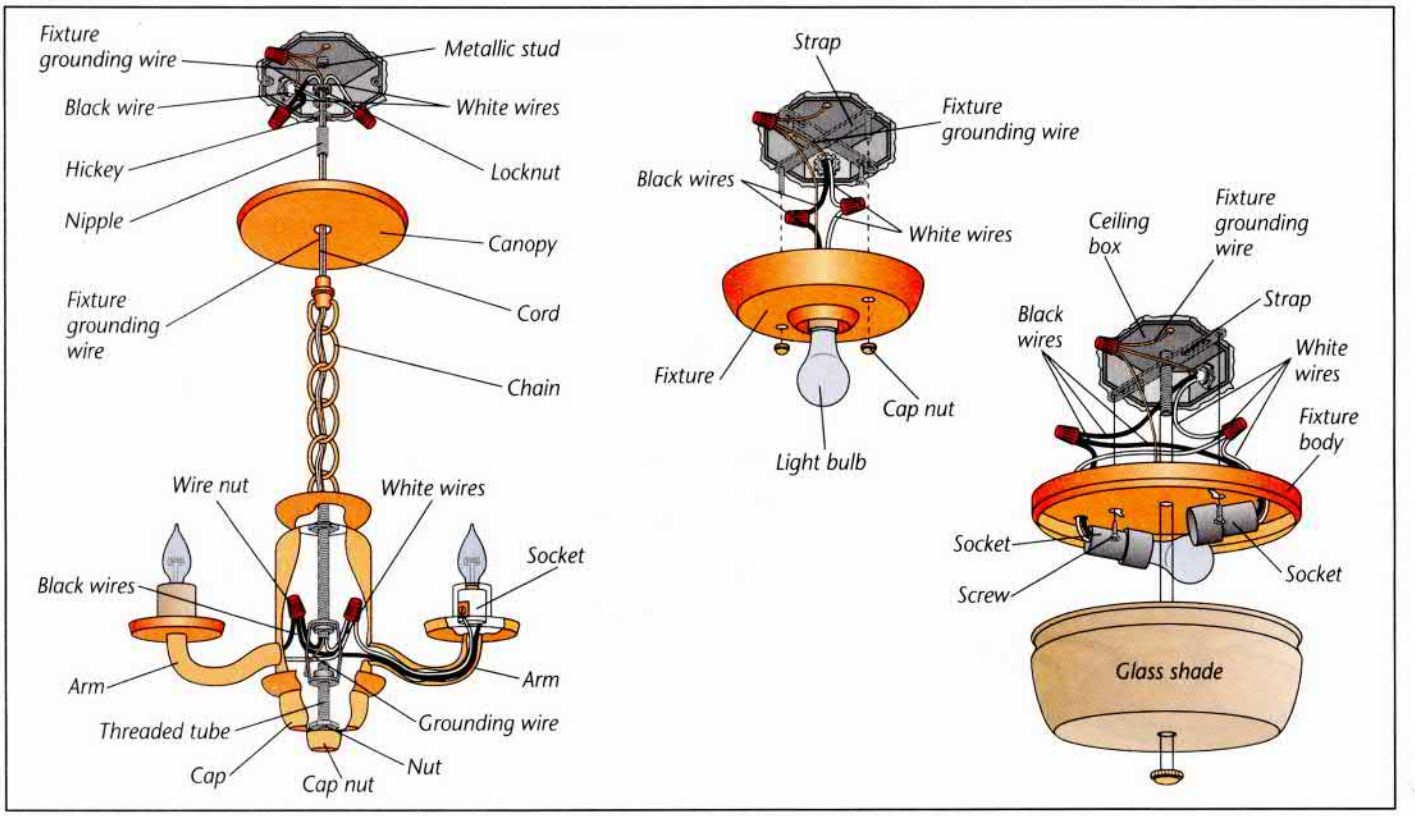
NOTE: If the fixture is heavy, have a helper hold it; or hang it from the box with a hook made from a wire coat hanger.

You may have to buy mounting hardware to hang the new fixture. If the ceiling box has a metallic stud, the fixture may be attached to it with a nipple and hickey, a reducing nut, or a strap *(see below)*. If there's no stud in the right location, the strap may be attached to the ceiling box ears. Fixtures heavier than 10 pounds should be hung from a box with a stud and nailed to the ceiling joists.

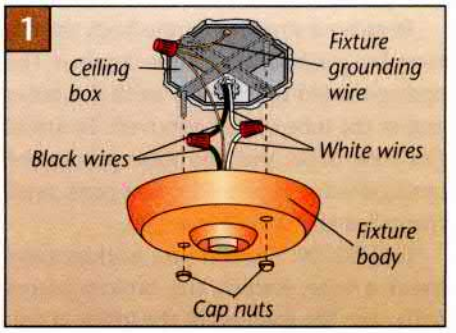
Repairing a fixture. Repair involves removing and replacing the sockets and/or wiring. Sockets in all types of fixtures may have terminal screws like a lamp socket *(page 163)*, or they may have permanently attached wires as shown in the center of the facing page. Use a continuity tester *(page 22)* to determine whether a socket is faulty. When you replace a socket, ensure polarity by connecting together wires of the same color.

On a chandelier, the sockets and socket wires in the arms are connected to a main cord running up the center. Usually, the connections are hidden inside the fixture body; you may have to remove a cap or nut on the bottom to reach them. Replace the main cord as you would a lamp cord *(page 163)*; to replace the socket wires and sockets, see the facing page. If you're replacing only sockets or socket wires and not the main cord, you can work with the chandelier in place.

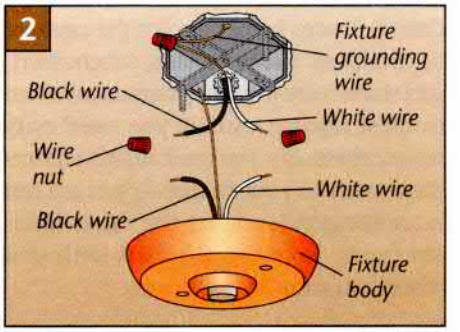
Types of ceiling fixtures



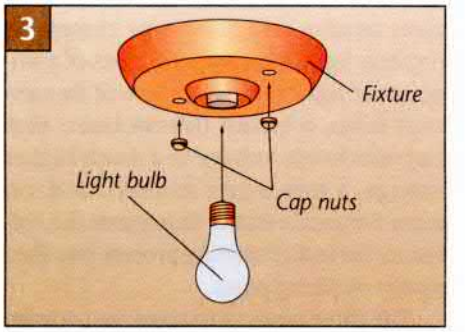
Replacing a fixture



Shut off power to the circuit and test to make sure it's off. Remove the bulb and unscrew the cap nuts to free the fixture from the screws on the ceiling box.

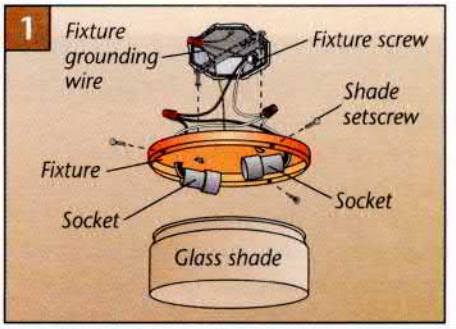


Disconnect the old fixture. Strip 1/2 inch of insulation off the new wires. Wrap the bare ends around circuit wires and bend over; install wire nuts. Connect grounding wires.

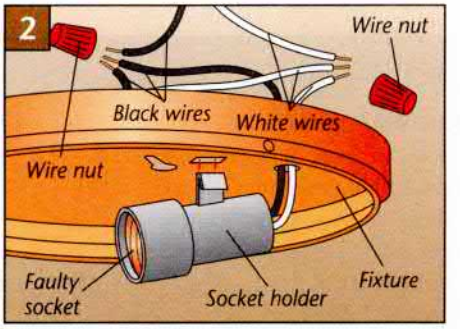


Carefully push the new fixture onto the screws that hold it to the ceiling box. Screw on the cap nuts to secure the fixture and replace the bulb.

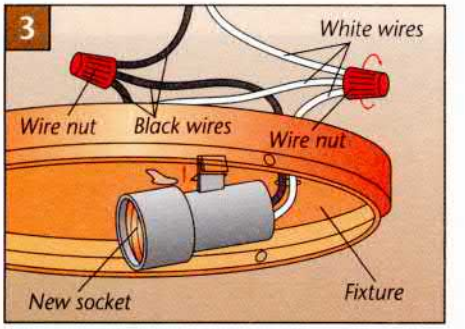
Replacing a prewired socket



To replace a prewired socket, turn off power to the circuit and test. Remove glass shade; unscrew the fixture screws to free the fixture.

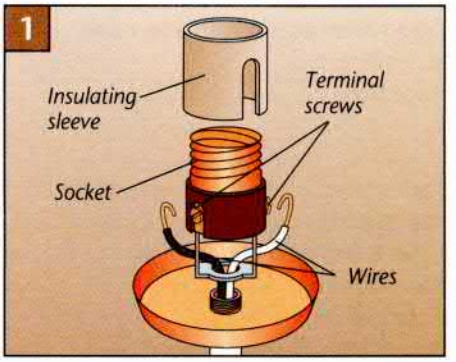


Unscrew the wire nuts to disconnect the socket wires from the circuit wires. Unclip and remove the faulty socket from the fixture.

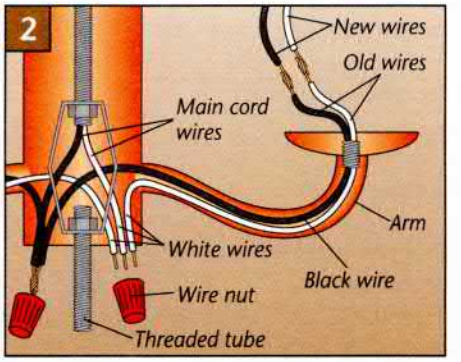


Attach the new socket. Push the wires through and splice them to the circuit wires with wire nuts. Reattach the fixture.

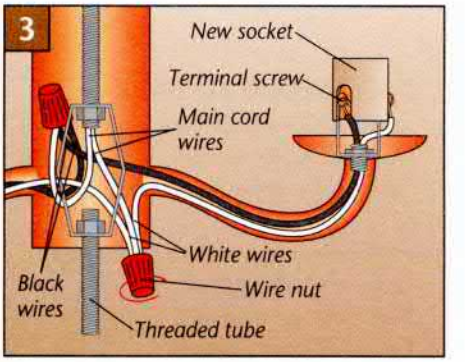
Rewiring a chandelier arm



Shut off power to the circuit and test to be sure it's off. Remove the sleeve, detach the wires from the socket terminal screws, and unscrew the socket.



Remove the cap under the fixture. Temporarily tape the new socket wires to the old. Detach the old wires from the main cord wires and pull the new wires through.



Screw on the new socket and connect the new wires. Remove the old socket wires and attach the new ones to the main cord wires; reassemble the fixture.

FLUORESCENT LIGHT FIXTURES

Unlike incandescent lights, which use house current directly, fluorescent fixtures require a high-voltage current to produce light. The working parts of a fluorescent light fixture consist of fluorescent tubes, a ballast (transformer) that converts house voltage to a much higher voltage, a tubeholder (socket), and, on some fixtures, a starter that assists the ballast in the initial starting process *(see illustration on facing page)*.

The three types of fixtures are preheat, rapid-start, and instant-start. On a preheat fixture, an older style, the starter is visible; it looks like a miniature aluminum can. On a rapid-start fixture, the starter is built into the ballast. An instant-start fixture has no starter and is distinguished by a tube with a single pin on each end.

You can easily make most repairs on a faulty fluorescent light fixture. Use the chart below to help pinpoint the cause of the problem. Tubes, ballasts, tubeholders, and starters are the components involved in most repairs; usually you need only replace them. But you must match replacement parts to your fixture—parts are not interchangeable among the three different types. Take the old parts with you when you shop for new ones.

Replacing a fluorescent tube. Before you remove a fluorescent tube, be sure to shut off the wall switch to the fixture.

To remove a double-pin tube, rotate it a quarter-turn in either direction and gently pull it out. Install the new tube by pushing it into the tubeholders and then giving it a quarter-turn to lock it into place.

Remove a single-pin tube from the fixture by pushing the tube against the spring-loaded tubeholder until the other end of the tube can be removed. To install the new tube, put the tube pin in the spring-loaded tubeholder and push until the other end can be inserted.

CAUTION: Should you accidentally break a tube, handle the broken pieces with care; the coating on the inside is poisonous. For this reason, dispose of old tubes carefully.

Replacing a starter. Before you replace a starter, shut off the wall switch to the fixture. To replace a starter on a preheat fixture, first remove the fluorescent tube.

Troubleshooting a fluorescent fixture

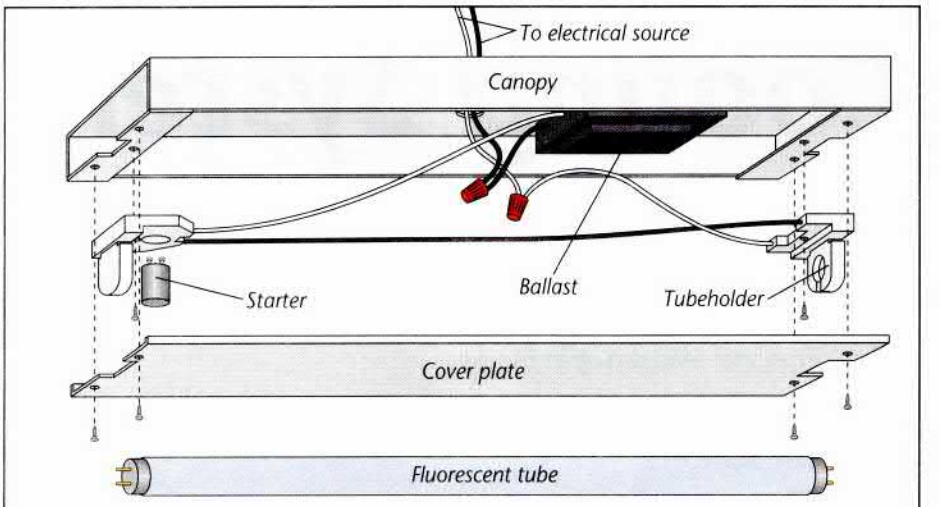
PROBLEM	POSSIBLE CAUSE	REMEDIES
Lamp won't light	Circuit breaker tripped or fuse blown	Reset circuit breaker or replace fuse*
	Tube burned out (ends blackened)	Replace tube
	Improper tube installation	Take out and install again
	Dirty tube (rapid-start only)	Remove tube; wash, dry, and reinstall
	Fixture too cold	Raise room temperature to at least 50°F
	Oxide film buildup on tube pins	Rotate tube in tubeholder once or twice
	Starter burned out	Replace starter on preheat type, ballast on rapid-start
	Tubeholder broken	Replace tubeholder
Lamp flickers (new tubes may flicker for a short time after installation)	Improper tube installation	Take out and install again
	Tube nearly worn out (ends blackened)	Replace tube
	Oxide film buildup on tube pins	Rotate tube in tubeholder once or twice
	Fixture too cold	Raise room temperature to at least 50°F
	Poor contact with tubeholders	Realign tubeholders; straighten and sand, if necessary
Ends of tubes are discolored (dark bands about two inches from ends are normal)	Tube nearly worn out	Replace tube
Preheat type with new tubes	Defective starter	Replace starter on preheat type, ballast on rapid-start
Discolored on one end only	Temperamental tube	Remove tube; turn end for end
Ends of tube glow, but center doesn't	Defective starter	Replace starter
	Defective ballast	Replace ballast
Lamp fixture hums	Ballast incorrectly installed	Check wiring diagram printed on ballast and correct
	Wrong type of ballast	Check watt rating and type; replace
	Defective ballast	Replace ballast

**If circuit breaker trips or fuse blows again, you have a short circuit (page 154); check wiring or call an electrician.*

Rotate the starter a quarter-turn counterclockwise and pull it out of its socket. Place the new starter in the socket and rotate it a quarter-turn in either direction.

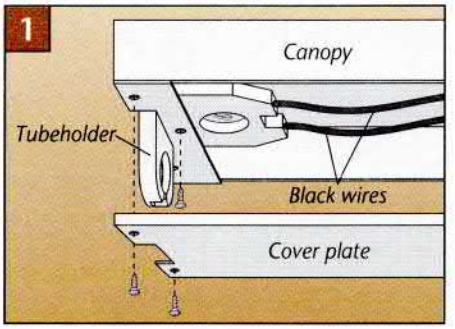
Replacing a tubeholder or ballast. Before you replace a tubeholder or ballast, shut off power to that circuit and test. Then follow the steps shown below. To connect the wires, you'll have to strip about 1/2 inch of insulation from the end of each wire and use wire nuts to connect the ballast or tubeholder wires to the fixture wires. If your new tubeholder has push-in connections or terminal screws instead of permanently connected wires, connect the fixture wires to these rather than using wire nuts. A new ballast will have permanently connected wires.

Parts of a fluorescent fixture

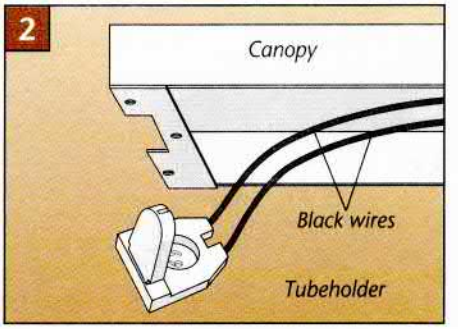


PREHEAT FIXTURE

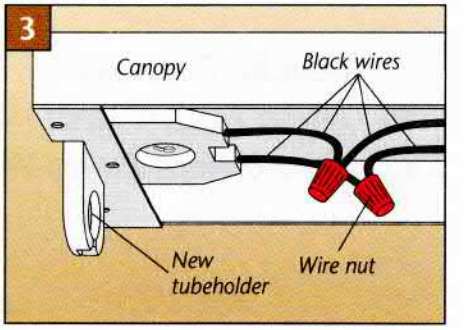
Replacing a tubeholder



To remove the old tubeholder, first turn off the power to the circuit and test with circuit tester. Remove the fixture's cover plate and fluorescent tube.

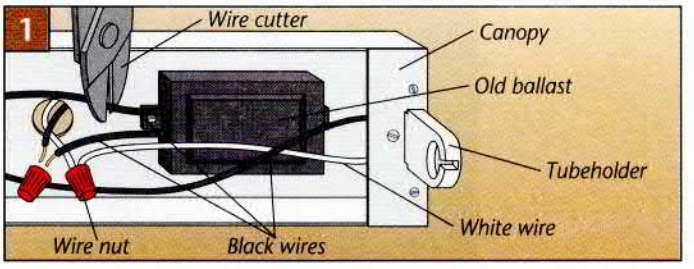


Unscrew or unsnap the tubeholder from the end of the fixture's canopy. Cut or disconnect the wires connecting the tubeholder to the fixture.

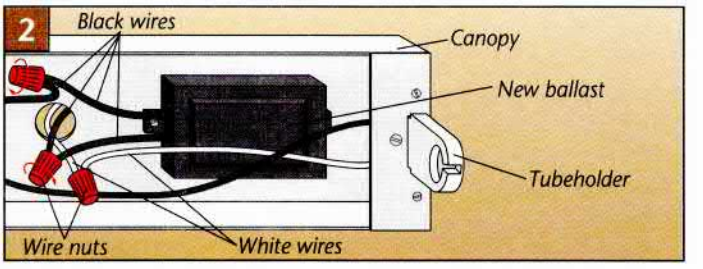


Connect the wires to the new tubeholder with wire nuts. Attach the new tubeholder, then install the cover plate and tube; turn on the power.

Replacing a ballast



To remove the old ballast, turn off the power to the circuit and test with circuit tester; remove the cover plate and fluorescent tube. Cut or disconnect the wires. Remove the ballast from the canopy.



Attach the new ballast to the canopy. Connect the ballast wires to the existing wires with wire nuts. Install the fluorescent tube and cover plate; turn on the power.

Heating & Cooling Systems

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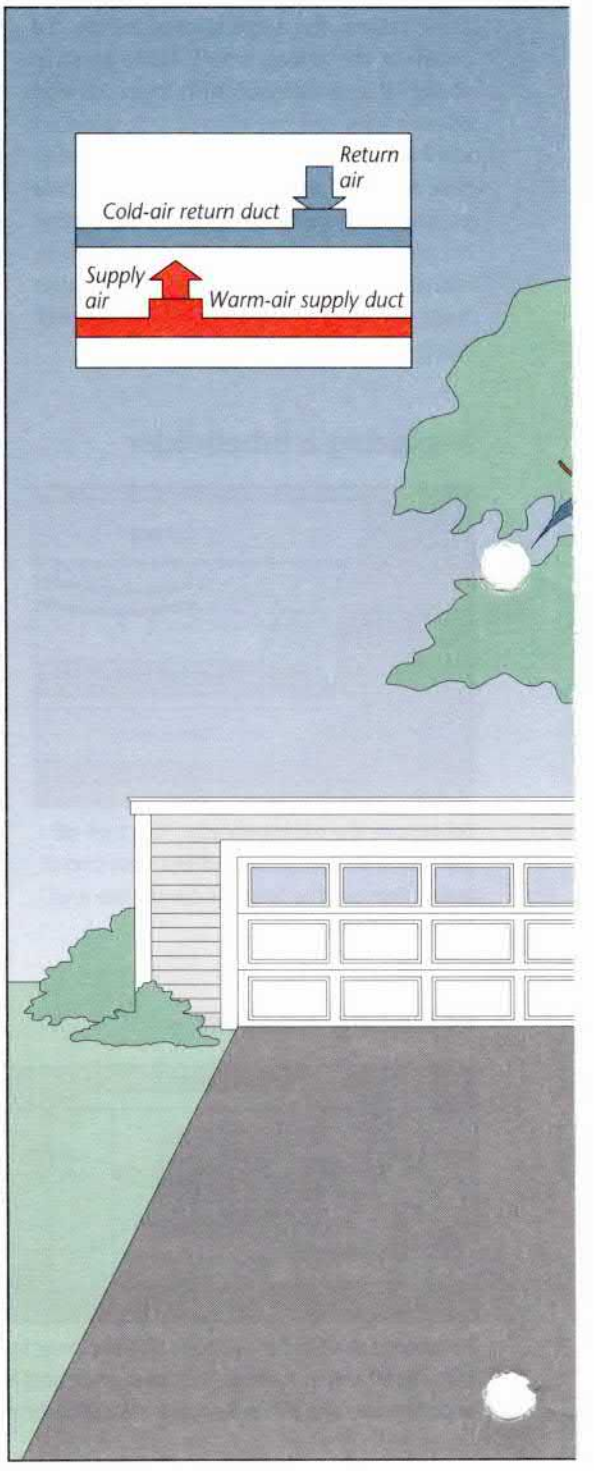
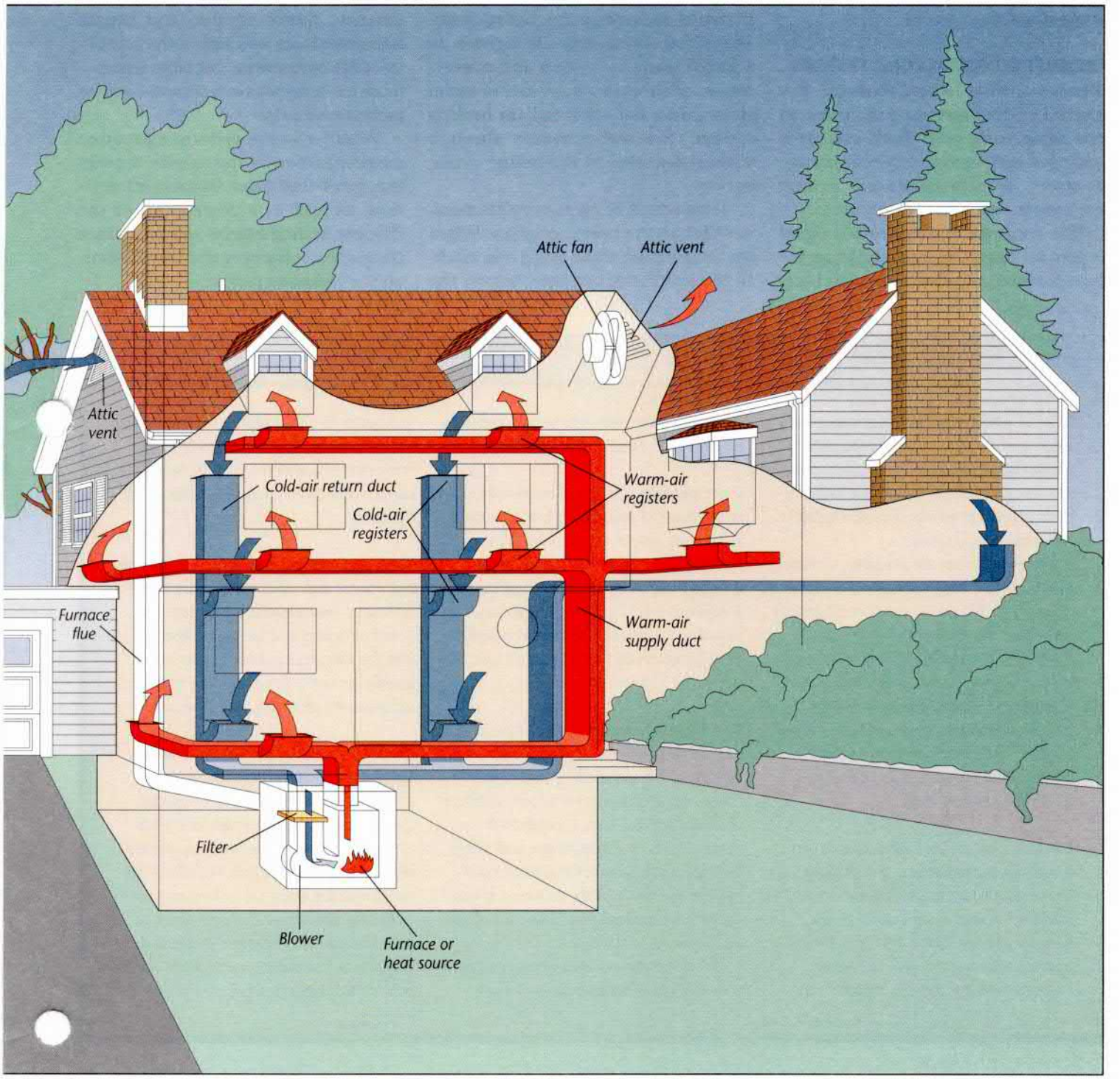


Your home may be heated by radiant warmth from steam, hot water, or warm air—and cooled by air conditioning or fans. The illustration below shows a house with a forced warm-air heating system. A basement furnace heats cold air drawn from the rooms above, then returns it via ducts and registers. An attic fan exhausts hot air through one side, allowing cooler air to enter through vents in the other side. For details on common heating and cooling systems, read on.



HEATING SYSTEMS

Heating systems can vary enormously, but all work toward the same goal—ensuring comfort in your home.

Most homes today are heated by forced warm air or hot water. Steam heat, found in older homes, is rarely installed now. Electric heat and heat pumps *(see below)* are the best choice in some situations.

UNDERSTANDING HEATING SYSTEMS

Steam, hot-water, forced warm-air, and electric heating systems all function in the same basic way. Each system is equipped with one or more temperature controls, a heat producer, a heat exchanger, and a heat distributor.

The controls, or thermostats, signal a need for heat. The signal turns on the heat producer, usually an oil or gas burner or an electric heating element; the heat warms the transfer medium—air, water, or steam—in the heat exchanger: a furnace if it heats air, a boiler if it heats water or produces steam.

The transfer medium moves by gravity or is forced through ducts (warm air) or pipes (water or steam) to the heat distributors located in the living areas. These heat distributors are registers in a forced warm-air system and convectors or radiators in a hot-water or steam system. In a hot-water radiant heating system, the water moves through tubing concealed in the ceiling, walls, or floor.

Return ducts or pipes carry the medium back to the heat exchanger. When the temperature of the living area reaches the level that has been set on the thermostat, the thermostat automatically shuts down the system. This process is repeated continuously.

CARING FOR YOUR SYSTEM

In general, heating systems operate reliably for many years, providing they're carefully maintained. Most routine maintenance, minor repairs, and simple adjustments are well within the capability of the homeowner. But other repairs—those too dangerous or technical—require professional help.

Whether you're performing routine maintenance or trying to solve a problem, you'll find much valuable information, as well as a description of the different heating systems and their major components, burners and thermostats, on the following pages.

Using Electric Heat

In areas where electricity is cheaper than either gas or oil, or when a remodeling project results in an increased demand for heat without increasing the capacity of the existing heating system, electric heat makes good sense.

Several options are available, including electric-fired boilers for hot-water systems *(pages 172-73)* and electric-fired furnaces for forced warm-air systems *(pages 174-175)*. Neither type requires a flue.

Other choices are electric heaters installed in existing warm-air ducts, baseboard heaters, small wall and ceiling heaters, and electric radiant-heating panels. Heat pumps *(page 181)* are also a source of electric heat.

Electric boilers and furnaces. In an electric boiler or furnace, the heating elements are immersed directly in the transfer medium, either water or air. Maintenance of such a system is similar to that required for a gas- or oil-fired boiler or furnace; making repairs to the electric heating elements should generally be left to a professional repairman.

Duct heaters. Designed for installation in the ducts of an existing forced warm-air heating system *(pages 174-175)*, duct heaters can be turned on at the same time as the blower or can be operated by a separate thermostat located in an area requiring supplemental heat. The heaters must be controlled so they don't turn on unless the blower is running.

Baseboard heaters. These heaters require no pipes or ducts—they connect directly to the electrical system in the house. A good choice for a room addition or a hard-to-heat area, a baseboard heater has its own thermostat and safety thermal cutoff switch. Most baseboard heaters are very reliable; however, if you do have a problem, you'll have to call for a professional electrician.

Some baseboard heaters use resistance coils that glow red hot; others have a resistance wire that heats a ceramic tube; still others have the heating element immersed in a sealed tube. The tubes are surrounded by fins that radiate heat into the room.

Wall and ceiling heaters. Suitable for bathrooms and other small areas, these resistance-heated units are mounted in a wall or ceiling and are wired directly into the electrical system. Newer units usually include a fan. Clean the heater occasionally; replace a defective one.

Radiant-heating panels and tiles. These may be electrically heated panels mounted in walls or ceilings or special gypsum board panels embedded with electric resistance wires installed in place of regular gypsum board. Both kinds are wired into the electrical system and controlled by a thermostat. Some types of floor tiles can also be wired in the same way. Once installed, these features usually provide trouble-free service for years.

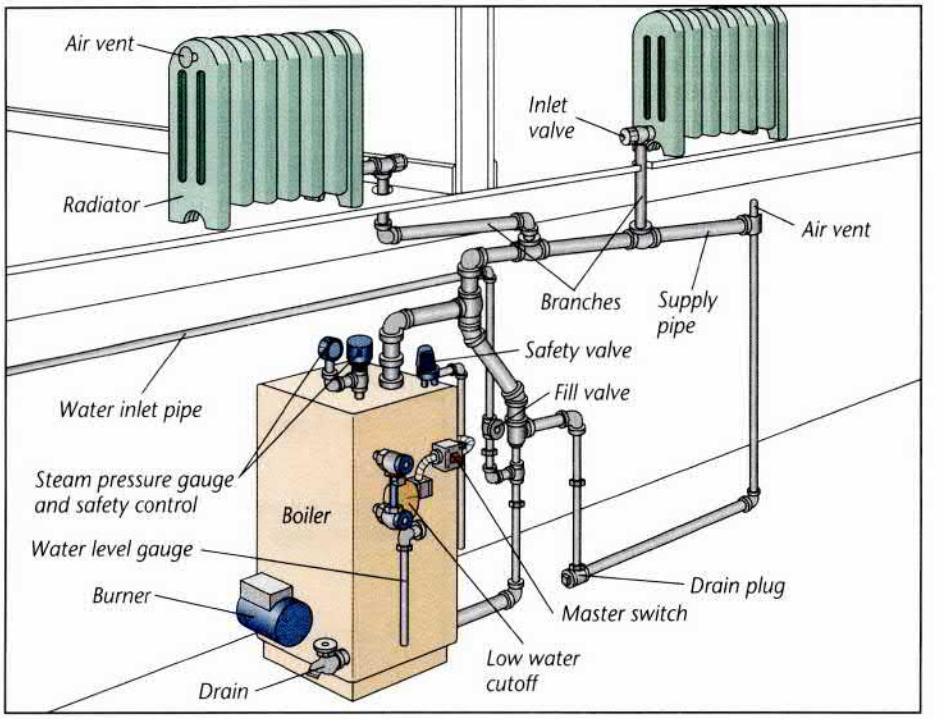
STEAM HEAT

A hallmark of many older homes, steam heat begins in a boiler fueled by gas, oil, or electricity. The boiler turns water into steam, which rises through pipes to radiators or convectors. There the steam gives up its heat and condenses into water, which returns to the boiler.

To maintain a steam heating system in good working condition, periodically check the safety valve, steam pressure gauge, and water level gauge, as explained below. Also regularly inspect your burner *(pages 176-179)* and thermostat *(page 180)*.

Some adjustments to a steam heating system are within the scope of the homeowner; others must be performed by a professional. The chart below describes problems you may encounter and how to remedy them.

A steam heating system



Safety valve. Located on top of the boiler, the safety valve allows steam to escape if the pressure in the boiler exceeds safe levels. Test the valve every month during the heating season by depressing the handle (stand clear of the valve pipe); if steam doesn't come out, have the valve replaced.

Steam pressure gauge. Tap the gauge lightly to make sure it's not stuck and check it to see that the pressure of the steam in the boiler is within normal bounds—typically 2 to 10 pounds per square inch (psi). If not, shut off the boiler and call for service.

Water level gauge. Once a month, open the valves at each end of the sight glass in the gauge—the water level should be in the middle of the glass. (Be sure to close the valves after checking.) If water is not visible, immediately shut off the boiler and let it cool; then add water by opening the fill valve on the water inlet pipe—unless your system has an automatic water fill valve; in that case, call for service.

To remove the sight glass for cleaning or replacement, shut off the valves and undo the collar nuts at each end of the glass. Install new gaskets when you reassemble the unit.

Troubleshooting a steam heating system

PROBLEM	POSSIBLE CAUSE	REMEDIES
No heat	No power	Check master switch and circuit breaker or fuse *(pages 151-152)*
	Not enough water in boiler	Add water by opening fill valve; **or adjust automatic fill valve***
	Defective thermostat	Clean or replace thermostat *(page 180)*
Cold radiator	Air vent plugged	Remove and clean or replace
	Closed inlet valve	Open valve completely
	Radiator out of adjustment	Adjust thermostatic air vent or thermostatic inlet valve; **if none, install thermostatic air vent***
Hammering noises	Radiator not sloped	Check radiator with a level, if not sloped slightly toward outflow end, shim opposite end

***This repair is best left to a professional.** Some problems may be burner-related; see pages 176-179.*

HOT-WATER HEAT

In a hot-water heating system, water heated in a boiler travels through a network of pipes to the heat distributors (usually convectors or radiators) where the heat is given off. The cooled water then returns to the boiler through the return pipe.

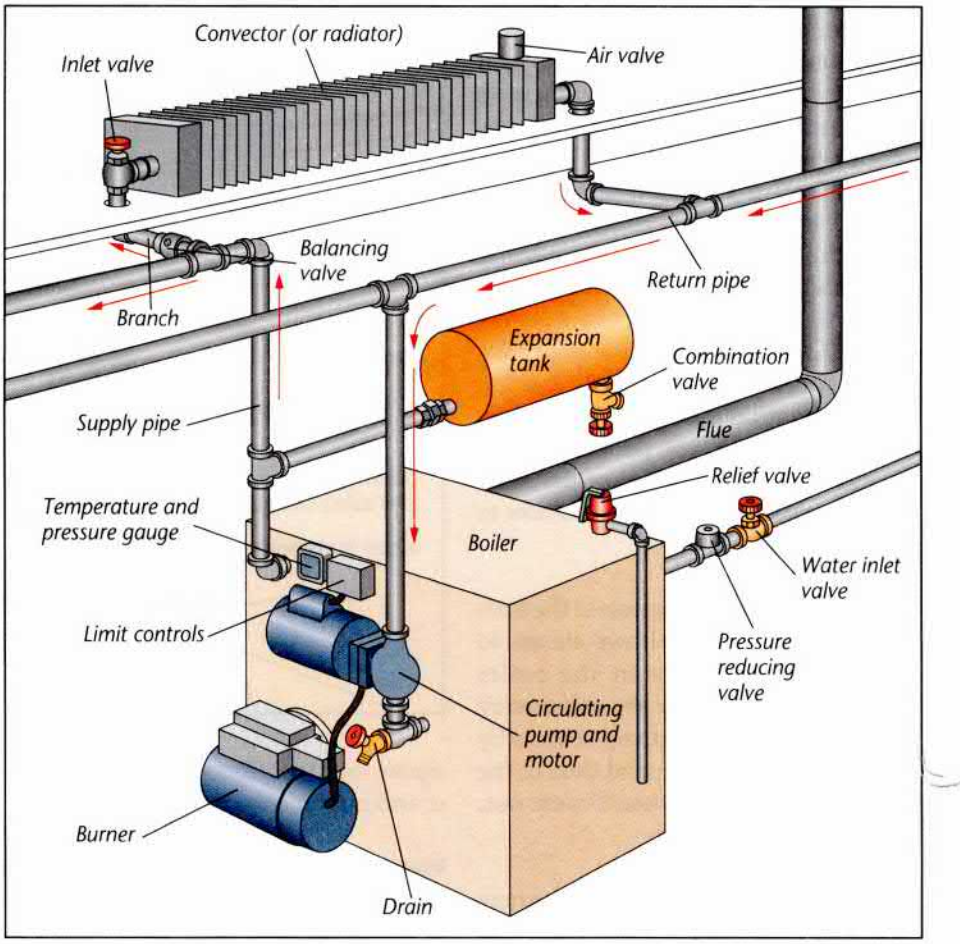
In older homes, the movement of water is governed by gravity—warmer, lighter water rises and takes the place of heavier, cooler water. The more modern hydropic systems employ a circulating pump to move the water under pressure; a thermostat governs the operation of the pump as well as the burner.

An expansion tank, usually mounted above the boiler, contains air and water; the air acts as a cushion to maintain heated water at the proper pressure.

With routine maintenance, a modern hot-water heating system will give you many years of trouble-free service. Check the system periodically; at the same time, take a look at the burner *(pages 176-179)* and the thermostat *(page 180)*.

If some parts of the house are too cold or too hot, follow the directions on the facing page to balance the system. Other problems you may encounter are discussed in the troubleshooting chart on the facing page.

A hot-water heating system



MAINTAINING THE SYSTEM

With regular maintenance and inspection, especially during the heating season, you can correct simple problems with a boiler that's not operating properly or with heat distributors that aren't working to capacity because air is trapped inside.

Checking the gauges. Mounted on the boiler are two gauges, one for water temperature and another for pressure or altitude (sometimes they're combined in a single housing, as illustrated above).

Water temperature is determined by the design of the system and the settings of the limit controls on the boiler. Adjusting the temperature is a job for a professional.

The pressure gauge *(illustrated on facing page)* provides a check on the water level. The fixed pointer, set when the system was installed, is a reference point for water level. The moving pointer indicates current water level and should align with the fixed one when the water is cold.

If the moving pointer reads higher, drain some water from the expansion tank *(see facing page)*. If it's lower and you have no pressure reducing valve, add water through the water inlet valve until the pointers are aligned.

In a system equipped with a pressure reducing valve, water level should be maintained automatically. If draining the expansion tank doesn't work or if the water level is too low, it's best to consult a professional.

Draining the expansion tank. A pressure gauge that reads high or a tank that feels hot indicates there's too little air in the expansion tank. Draining some of the water from the tank, as shown on the facing page, will restore the proper air-water ratio. You can do the job yourself, unless you have a diaphragm tank; in that case, you will have to call for professional service.

To drain the tank, turn off the power and the water to the boiler; let the water in the tank cool. Attach a hose to the combination valve and open it. Let water flow out until the pointers on the pressure gauge coincide. Close the valve, then restore power and water.

Checking the relief valve. This valve releases excess pressure. Once a month, lift the valve lever; if no water flows from the valve, replace it.

Bleeding the convectors or radiators. Convectors and radiators will not heat properly if air is trapped inside. If your units don't have automatic air valves, you'll need to bleed the air from them *(see illustration at right below)* at the beginning of each heating season, whenever you add water to the heating system, or if a convector or radiator remains cold when it shouldn't.

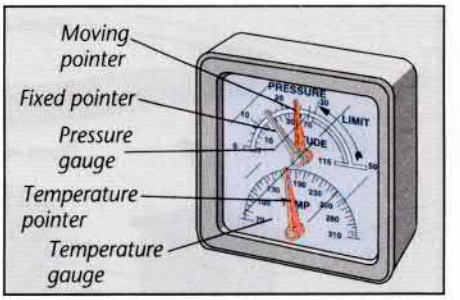
Depending on the type of valve, use a wrench, screwdriver, or special key to open the valve. When water spurts out, close the valve.

BALANCING THE SYSTEM

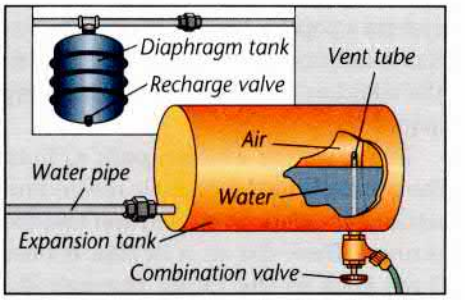
Unless your system has zone controls that automatically control water temperature in specific areas, you may need to balance your system to compensate for overly cold or overly warm rooms.

Turn the system on and let room temperatures stabilize before you start. To adjust a convector or radiator, gradually open or close the balancing valve on that branch or the inlet valve on the affected convector or radiator *(see at right)*. Be patient—it may take several days of adjustments to bring the system into balance.

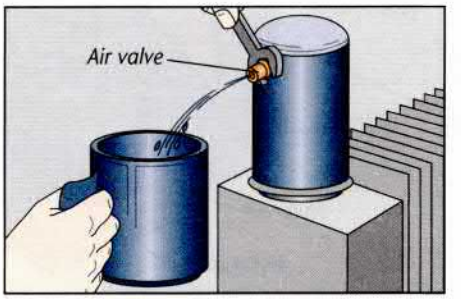
Four adjustments to the system



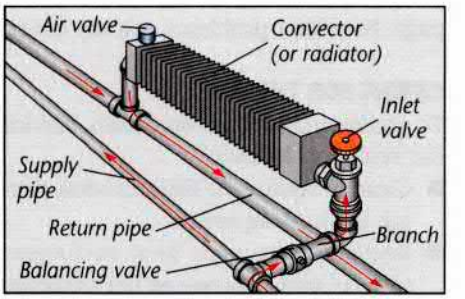
To align the pressure gauge pointers, drain the expansion tank if the moving pointer is higher than the fixed one; add water if it's lower.



To drain an expansion tank, close the water inlet valve and open the combination valve (attach hose first). Let a professional drain a diaphragm tank (see inset).



To bleed the air from the convectors or radiators, open each air valve. Close the valve when water spurts out (use a cup to catch water). CAUTION: Water may be hot.



To adjust the temperature of a convector or radiator, open or close the inlet valve or alter the water flow by adjusting the balancing valve in that branch.

Troubleshooting a hot-water heating system

PROBLEM	POSSIBLE CAUSE	REMEDIES
No heat	No power	Check master switch and circuit breaker or fuse *(pages 151-152)*
	Closed fuel supply valve	Open oil or gas inlet valve
	Dirty or defective thermostat	Clean or replace thermostat *(page 180)*
Cold convector or radiator	Air in convector or radiator	Bleed convector or radiator *(see text)*
Leaking inlet valve stem	Worn stem packing	Drain water in system below level of valve and replace packing as for a faucet *(page 112)*; then refill system and bleed convector or radiator *(see text)*
Leaking circulating pump	Defective seal or impeller	**Replace seal or impeller***
Noisy circulating pump	Broken coupling	**Replace coupling***
Water dribbling from relief valve	Too much water in expansion tank	Drain expansion tank to restore proper air-water ratio *(see text)*

***This repair is best left to a professional.** Some problems may be burner related; see pages 176-179.*

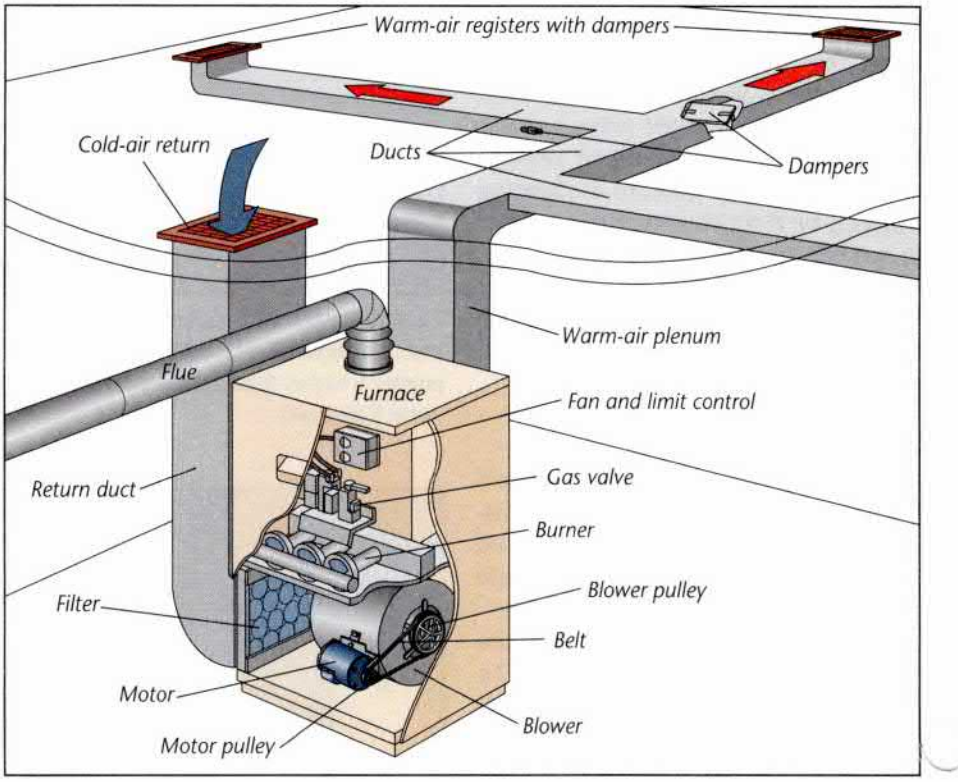
FORCED WARM-AIR HEAT

Low installation cost, fast heat delivery, and reliability make forced warm-air systems a popular heating choice. The system is also very versatile, lending itself to the addition of central air conditioning *(page 183)*.

In this system, a blower pulls air from the rooms into the cold-air return and return duct, through a filter, and into the furnace. There the air is heated. It then flows back to the rooms through the warm-air ducts and registers.

For maximum efficiency, clean the system *(see below)* and inspect the burner *(pages 176-179)* and thermostat *(page 180)*. A system that's working inefficiently can be adjusted, as explained on the facing page. For other problems, see the chart.

A forced warm-air heating system



CARING FOR THE SYSTEM

To ensure trouble-free operation, service the system as follows:

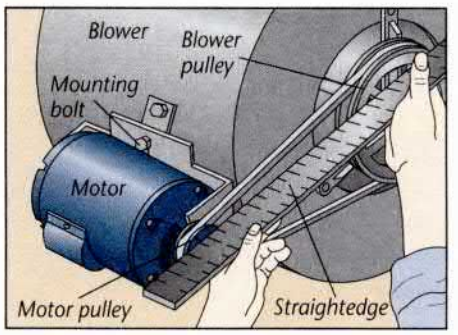
- Clean or replace the filter monthly during the heating season.
- Brush and vacuum heat exchanger surfaces annually (see owner's manual for instructions).
- Clean the blower blades at the start of each heating season; add a few drops of motor oil to each oil cup if your blower is equipped with them.
- Check and adjust both belt alignment and belt tension *(see illustrations below)* if your furnace has a belt-driven blower. To replace a belt that is worn or otherwise damaged, first loosen the motor adjustment bolt, remove the old belt, and attach a new one. Adjust the blower as shown.
- Examine the ducts annually for leaks; seal any leaks with duct tape.

BALANCING THE HEAT

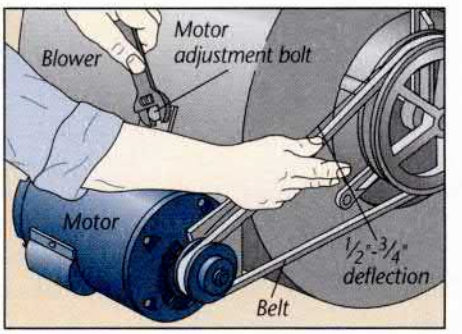
If some rooms are too hot or too cold, try adjusting the dampers in the registers and, if your system has them, the dampers in the warm-air ducts.

On a typical cold day, leave the thermostat at one setting and let the system

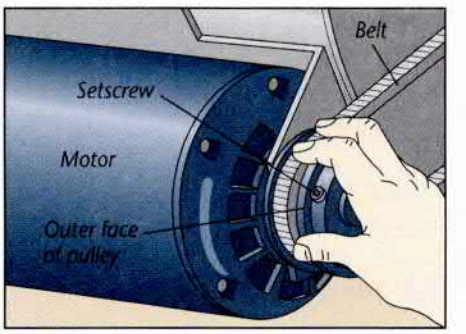
Three blower adjustments



Check the pulley alignment by placing a straightedge against the pulley faces. If they're not aligned, loosen the mounting bolts and adjust the motor pulley.



To check belt tension, push the belt—it should deflect 1/2 to 3/4 inch. Turn the adjustment bolt and move the motor away to tighten the belt, closer to loosen it.



To speed up the blower and increase air flow, loosen the setscrew and turn the outer pulley face clockwise; turn it counterclockwise to slow down the blower.

run for 3 hours to stabilize the temperatures. Open the dampers wide in the coldest rooms. Then adjust the dampers room by room until temperatures are balanced. Wait half an hour or so after each adjustment before rechecking or readjusting.

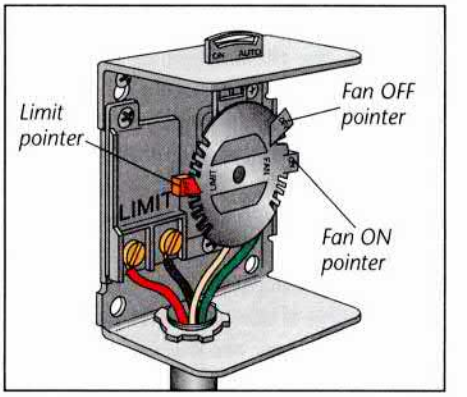
In homes that are hard to heat, maximum comfort can be achieved by adjusting the blower so that it runs constantly at a lower level throughout the day. To do this, adjust the motor pulley of a belt-driven motor *(see facing page, bottom)* or, for a direct-drive blower, change the electrical connections (see owner's manual) for a slow blower speed that produces a 100°F temperature rise through the furnace while the furnace is firing.

SETTING THE FAN CONTROL

If you're chilled by a blast of cool air when the blower turns on, try adjusting the fan control *(see at right)*. CAUTION: If your furnace has a combination fan and limit control, do not touch the pointer on the limit control side. This pointer turns off the furnace if the maximum allowable air temperature is exceeded.

As the blower turns on, hold your hand in front of the warm-air register farthest from the furnace. Your hand should feel neither cooler nor warmer. If it feels cooler, uncover the control and move the fan control's ON pointer a few degrees higher. Adjust as needed. To increase fuel efficiency, check the air just before the blower shuts off. If your hand feels warmer, move the OFF pointer a few degrees lower.

Setting the fan control



To adjust the temperature of the air coming out of the registers, move the ON pointer to set the temperature at which the blower turns on, the OFF pointer to set the temperature at which it turns off.

Troubleshooting a forced warm-air heating system

PROBLEM	POSSIBLE CAUSE	REMEDIES
No heat	No power	Check master switch and circuit breaker or fuse *(pages 151-152)*
	Defective thermostat	Clean or replace thermostat *(page 180)*
Insufficient heat	Clogged filter	Clean or replace filter
	Dry heat exchanger	Brush and vacuum *(see owner's manual)*
	Leaking air ducts	Seal leaks with duct tape
	Blower operating too slowly	Adjust blower speed *(see text)*
	Loose blower belt	Tighten belt *(see text)*
Blower doesn't operate	Broken belt	Replace belt *(see text)*
	Fan control too high	Adjust fan control *(see text)*
	Defective blower motor	Repair or replace motor
Noisy blower	Insufficient lubrication	Put oil in cups, if any
	Loose or worn blower belt	Tighten or replace belts *(see text)*
Blower cycles too rapidly	Fan control differential too low	Adjust fan control *(see text)*
	Blower operating too fast	Adjust blower speed *(see text)*
	Defective fan and limit control	**Replace fan and limit control***
Room temperature exceeds thermostat setting	Thermostat improperly located	**Move thermostat***
	Thermostat improperly installed	Install thermostat properly
Room temperature doesn't reach thermostat setting	Thermostat improperly located	**Move thermostat***
	Thermostat improperly installed	Install thermostat properly
	Dirty thermostat contacts	Clean contacts *(page 180)*
	Clogged filter	Clean or replace filter
	Blower operating too slowly	Adjust blower speed *(see text)*
	Fan control too low	Adjust fan control *(see text)*
	Thermostat improperly calibrated	**Recalibrate thermostat***

***This repair is best left to a professional.** Some problems may be burner-related; see pages 176-179.*
Furnace models vary; see your owner's manual for specifics.

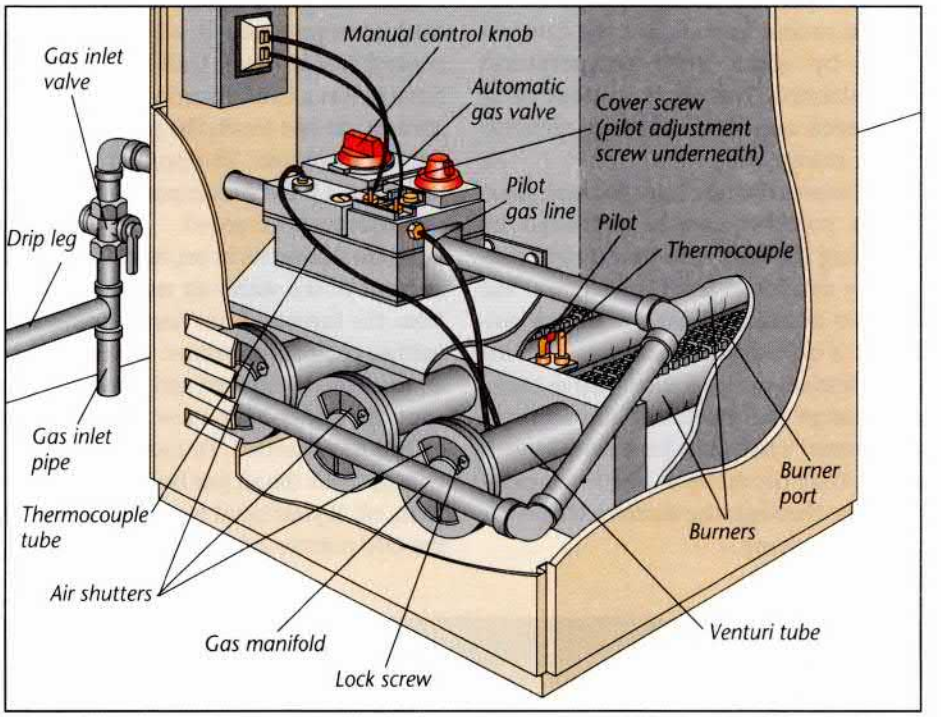
GAS BURNERS

Extremely common for home heating use, gas burners can fuel forced warm-air, hot-water, or steam heating systems.

When the thermostat in the system calls for heat, the burner's automatic gas valve opens, allowing gas to flow into a manifold and then into venturi tubes where it mixes with air. When the air-gas mixture emerges from the burner ports, the pilot ignites it and heat is created. A thermocouple adjacent to the pilot closes the gas valve if the pilot isn't working.

Whether they are fueled by natural, manufactured, or bottled or liquefied petroleum gas, gas burners are generally reliable and require little routine maintenance. Problems you may encounter are discussed below and in the chart on the facing page.

A typical gas burner



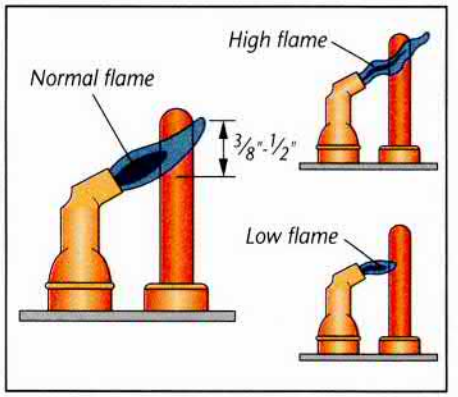
SOLVING PILOT PROBLEMS

Pilots in gas burners may be electric or gas. For problems with electric pilots, call in a professional. Gas pilots can be relit and cleaned by the homeowner.

Lighting a gas pilot. Before you try to relight a pilot that has gone out, read the instructions, usually printed on the front of the boiler or furnace. If there are none, have your utility company light the pilot or follow these steps: Use the manual control knob on the automatic gas valve to turn off the gas to the main burner and pilot. Allow at least 5 minutes for accumulated gas to dissipate before proceeding. Use extreme caution—and take more time—if your fuel is bottled gas; it doesn't dissipate readily.

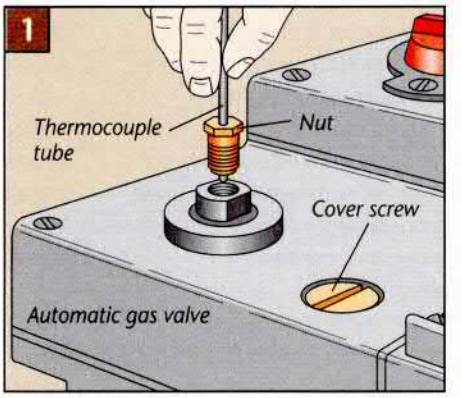
When the gas has dissipated, set the thermostat well below room temperature. Turn the manual control knob to PILOT and light the pilot, holding the knob there for a minute. Release the knob and turn it to ON. If the pilot doesn't stay on, refer to the chart on the facing page or call the

Adjusting the pilot

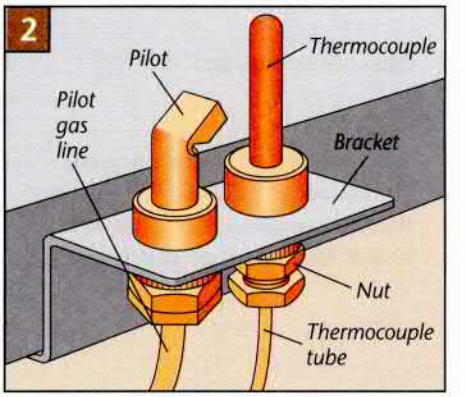


To adjust the pilot flame to the normal position, turn the pilot adjustment screw (under cover screw) clockwise to reduce the flame, counterclockwise to increase it.

Replacing a thermocouple



To replace the thermocouple, turn the manual control knob to OFF; then unscrew the nut that secures the thermocouple tube to the automatic gas valve.



Unscrew the nut holding the thermocouple to the bracket; remove the thermocouple and tube. Attach the new unit to the bracket and gas valve; relight the pilot.

gas company. (Remember to reset the thermostat when the pilot is relit.)

Adjusting the pilot flame. The pilot flame should be blue and should cover the thermocouple. Before adjusting the flame *(see facing page, bottom)*, turn the thermostat down and turn off power to the system. Reset thermostat when done.

Cleaning the pilot orifice. If you have trouble lighting the pilot, the orifice may be plugged. To clean it, first shut off the gas supply by turning the gas inlet valve handle so it's at a right angle to the pipe. Next, disconnect the thermocouple tube and the pilot gas line from the automatic gas valve. Then remove the bracket holding the pilot and the thermocouple.

Use stiff wire to clean the orifice (be careful not to chip it). Reattach the bracket, pilot gas line, and thermocouple tube. Turn on the gas and relight the pilot.

CLEANING THE BURNERS

Clogged gas burners and ports heat inefficiently. Clean them at the start of the heating season.

To reach the ports, shut off the gas inlet valve and remove the bracket holding the pilot and thermocouple. Remove any screws or nuts holding the burners and maneuver them carefully out of the combustion chamber.

To clean the burners, scour them with a stiff wire brush; clean the burner ports with stiff wire that's slightly smaller than the diameter of the openings.

After cleaning, reassemble the burners in the combustion chamber, replacing any screws or nuts that secured the burners. Then mount the bracket holding the pilot and thermocouple. Turn on the gas and relight the pilot *(see facing page)*. Be sure to adjust the air-gas ratio, as explained in the next paragraph.

ADJUSTING THE BURNERS

For maximum efficiency, burners fueled with natural gas should burn with a bright blue flame that has a soft blue-green interior and no yellow tip. (Check with your gas company for the correct colors for other types of gas.)

To correct the air-natural gas ratio, you'll need to adjust the air shutters. Turn up the thermostat so the burners light and loosen the lock screws. Slowly open each shutter until the flames are bright blue, then close the shutters gradually until yellow tips appear. Slowly reopen the shutters until the yellow tips just disappear; tighten the screws.

Troubleshooting a gas burner

PROBLEM	POSSIBLE CAUSE	REMEDIES
Burner doesn't operate	No power	Check master switch and circuit breaker or fuse *(pages 151-152)*
	Closed gas inlet valve	Open valve so handle is parallel to pipe
	Closed automatic gas valve	Turn control knob to ON
	Improperly set or defective thermostat	Check thermostat setting and, if automatic setback type, check clock setting; replace if defective *(page 180)*
	Pilot extinguished	Relight *(see text)*
Pilot won't light	Dirty pilot orifice	Clean orifice with stiff wire *(see text)*
	Loose or defective thermocouple	Tighten nut; or replace thermocouple *(see text)*
Pilot won't stay lit	Pilot not heating thermocouple	Increase flame *(see text)* or reposition pilot
	Excessive draft	**Install draft diverter***
	Defective thermocouple	Replace thermocouple *(see text)*
Insufficient heat	Burner flame not properly adjusted	Fully open gas inlet valve (handle parallel to pipe); adjust air shutters on burners *(see text)*
	Clogged burner ports	Clean burners and ports *(see text)*
Delayed burner ignition	Clogged burner ports near pilot	Clean ports with stiff wire *(see text)*
	Pilot not properly adjusted	Increase flame *(see text)* or reposition pilot and thermocouple
Burner won't turn off	Short circuit or defective automatic gas valve or furnace limit switch	IMMEDIATELY close inlet valve, leaving electric power on, and call utility company
Gas odor	Gas leak, loose connection, or broken gas line	IMMEDIATELY get everyone out of the house, close main gas supply to house, and call utility company from a neighbor's house

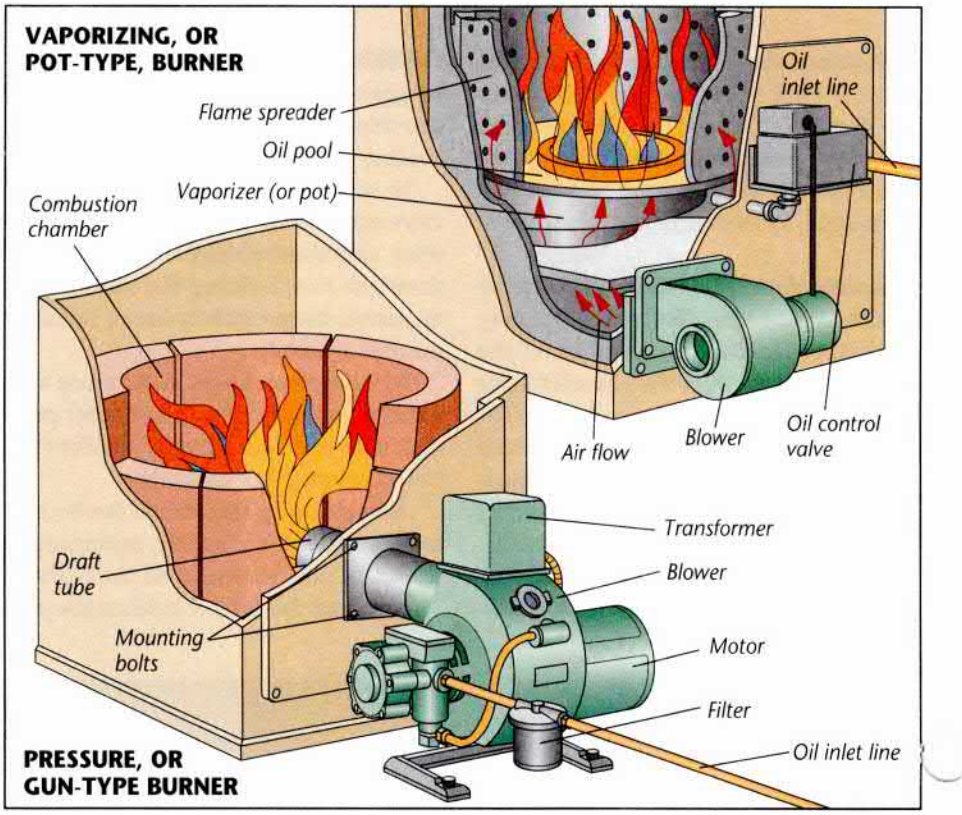
***This repair is best left to a professional.** Some problems may be furnace- or boiler-related; see pages 171-175.*

OIL BURNERS

Two types of oil burners are used to produce heat in forced warm-air, hot-water, and steam heating systems for the home. The most common is the pressure, or gun-type, burner; the vaporizing, or pot-type, burner is used only in small furnaces.

Most oil burners run for years with few problems. For greatest efficiency, call in a professional every year to service your burner. Check a pressure-type burner regularly during the heating season and clean it as needed; for remedies of common problems, see the chart on the facing page. Most problems that occur with vaporizing burners are best left to a professional.

Two types of oil burners



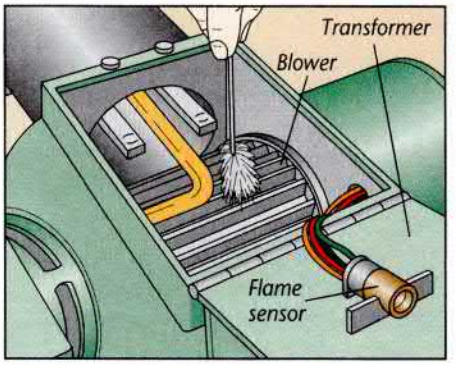
HOW OIL BURNERS WORK

When the thermostat of a heating system equipped with a pressure-type burner demands heat, the burner motor turns on, pumping filtered fuel oil under pressure through a noble, forming a mist. At the same time, the burner's blower forces air through the draft tube where it mixes with the oil mist. As the mixture enters the combustion chamber, it's ignited by a high-voltage spark between two electrodes located at the end of the draft tube.

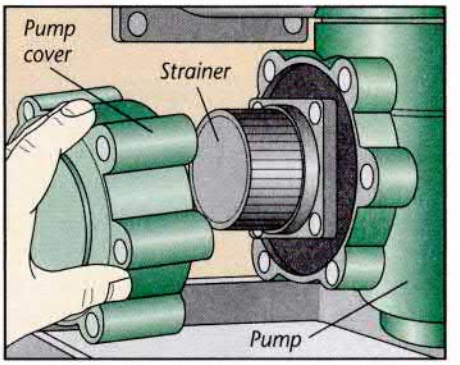
When a vaporizing burner is turned on, the oil control valve opens, allowing oil to pool in the pot. An electric spark ignites the oil, and the heat of the burning oil causes more oil to vaporize. These vapors combine with a blower-induced or natural air draft and the mixture burns in the combustion chamber.

If the oil in either type of burner does not ignite, the burner is turned off by a flame sensor in the burner itself or by a heat sensor that is situated on the stack control attached to the flue. This mechanism prevents the boiler or furnace from being flooded by oil.

Cleaning the blower and strainer

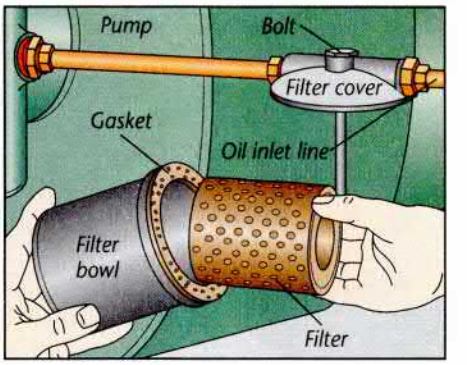


Clean the blades of the blower with a small brush after lifting the cover (the transformer may be attached to the cover). (Turn off power to the heating system first.)



To reach fuel pump strainer, unscrew the pump cover. Remove the strainer and clean it in mineral spirits or kerosene.

Replacing the filter



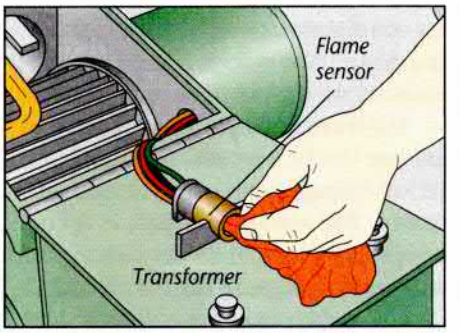
To replace the filter and gasket, shut off the valve between the filter and tank; unscrew the bowl from the cover and change the filter and gasket.

SERVICING YOUR BURNER

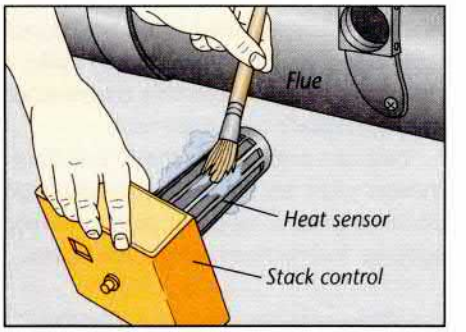
Professional service that includes a thorough inspection and cleaning of your burner, as well as a check of its efficiency, should be carried out annually.

To keep repair and fuel bills at a minimum, inspect and clean your pressure-type burner several times between service calls. Lubricate the motor and blower bearings by pouring oil in the oil cups if the motor and blower are equipped with them. Clean the blower, oil strainer, and sensors and, when necessary, replace the filter and gasket *(see at right and facing page)*. Be sure to turn off the power to the burner before you begin work.

Cleaning the sensors



Clean the flame sensor with a soft cloth after lifting the blower cover. If your flame sensor is located at the end of the drain tube, rely on a professional.



Clean the heat sensor on the stack control with hot soapy water and a brush after removing the control from the flue; dry and replace the control.

Troubleshooting an oil burner

PROBLEM	POSSIBLE CAUSE	REMEDIES
Burner doesn't operate	No power	Check master switch and circuit breaker or fuse *(pages 151-152)*
	Defective thermostat	Clean or replace thermostat *(page 180)*
	Tripped stack control	Reset twice; then call for service
	Tripped motor relay	Reset twice; then call for service
	Open furnace limit control	Reset twice; then call for service
	Defective motor or motor relay	**Repair or replace motor or motor relay***
Burner operates but doesn't light	Low oil level	Fill tank
	Dirty electrodes	**Clean or replace electrodes***
	Cracked electrode insulators	**Replace insulators***
	Loose electrode wiring connections	Shut off power and tighten connections
	Defective transformer	**Replace transformer***
	Dirty oil filter or strainer	Clean or replace filter, or clean strainer *(see text)*
	Clogged nozzle	**Clean or replace nozzle***
Burner runs intermittently	Dirty oil filter or strainer	Clean or replace filter, or clean strainer *(see text)*
	Air leaks	Tighten connections and valve packings in oil inlet line; tighten filter and strainer covers
	Water in oil	**Repair leak in oil line outside foundation or pump out tank and clean or repair***
	Poor flame	**Check nozzle, nozzle size, air adjustment, and oil pressure***
Smoky flame	Incorrect air-oil ratio	**Open air shutters to increase air flow***
Noisy burner	Air in oil inlet	Tighten all connections and valve packings in inlet line; tighten filter and pump covers
	Misaligned motor and fuel pump	**Realign motor and pump***
	Noisy pump	**Replace pump***
	Loose mounting bolts	Tighten bolts

***This repair is best left to a professional.** Some problems may be furnace- or boiler-related; see pages 171-175.*

THERMOSTATS

Thermostats for heating or air conditioning systems rarely break down. The only maintenance required is an occasional light cleaning. Don't attempt to make a major repair on a defective thermostat; instead, replace the entire unit.

You can replace a bimetal coil thermostat with an electronic model that allows a greater range of programming options. Instructions are shown below.

How thermostats work. A thermostat is a type of switch that is turned on by a temperature-sensitive device that, in turn, activates the switch controlling the operation of a boiler, furnace, electric heater, air conditioner, or other heating or cooling device. Low-voltage and millivolt thermostats are the most common types.

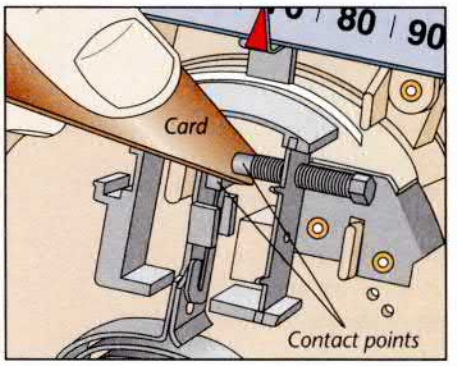
The three principal parts of a thermostat are the heat sensor, the switch, and, in low-voltage types only, the heat anticipator. The sensor contracts as it cools, tripping the switch to ON and expands as it warms, tripping the switch to OFF.

The switch may have open contacts (in older models) or a mercury-type contact enclosed in an airtight glass tube. The anticipator prevents the living area from overheating by shutting off the boiler or furnace just before the desired temperature is reached.

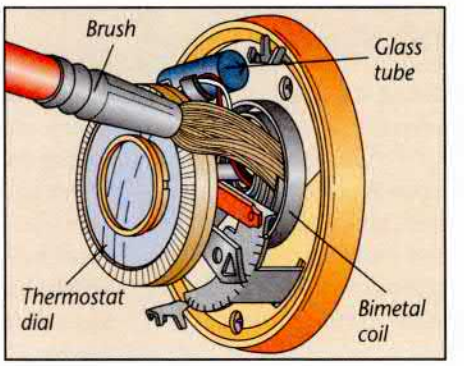
Cleaning a thermostat. Gentle cleaning helps ensure trouble-free operation.

First, you'll need to remove the cover of the thermostat. Then follow the instructions below to dust the heat sensor and, if your thermostat has them, exposed contact points and switch contacts. Many electronic thermostats are wireless and snap in and out of place.

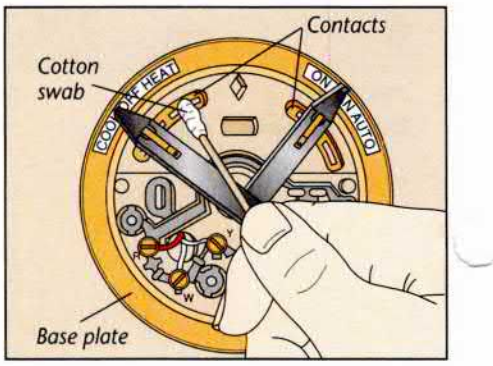
Cleaning a bimetal coil thermostat



To clean the contact points, turn the thermostat up until the points close; remove the cover and wiggle a strip of thin card between the points. Blow clean.

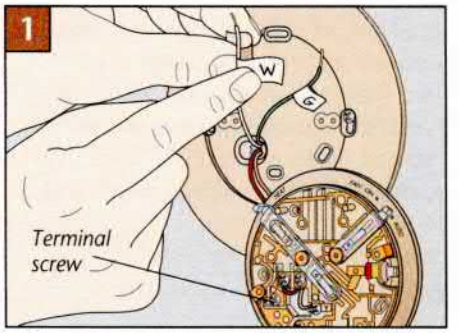


To clean the heat sensor's bimetal coil (or element), remove the cover and gently brush the coil with a soft brush; blow the thermostat clean of debris.

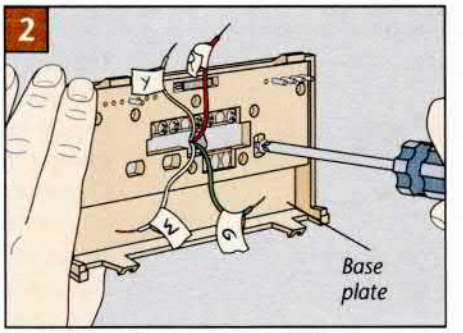


To clean the switch contacts, if your thermostat is equipped with them, remove the cover and clean the contacts with a cotton swab moistened with alcohol.

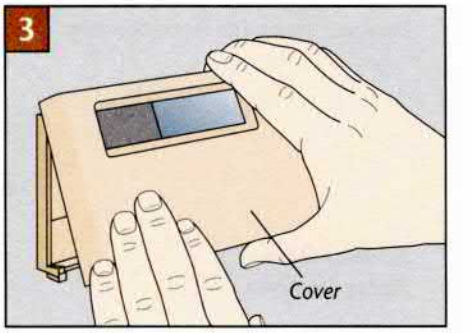
Installing an electronic thermostat



Remove the cover and detach the wires from their lettered terminals. Flag and label each wire to ensure you hook them up to the correct terminal and so they do not slide back into the hole.



Attach the new base plate to the wall with screws, checking to ensure it's level. Strip the wire ends, if needed, or scrape them clean; wrap the ends clockwise around the terminal screws and tighten the screws.



Mount the thermostat cover on the base plate following manufacturer's instructions. The model shown clips in place.

AIR CONDITIONING SYSTEMS

Air conditioners are a blessing in hot climates. Not only do they cool the air, but many dehumidify and filter the air as well. The two most common types of air conditioning systems for the home are evaporative and refrigerated. Both can cool just a single room or an entire house; most types are controlled by a thermostat.

Evaporative air conditioners, also called swamp coolers, work well in dry desert regions. Refrigerated units, though more expensive to purchase than evaporative ones, are the only way to cool air in other than desert climates. Included in the category of refrigerated units are both room air conditioners, fitted into a wall or window, and central air conditioning *(page 183)*. Another type of refrigerated system, a heat pump, cools and heats a house *(see below)*.

The energy cost of most air conditioning systems is high, so it's important that your system be properly maintained and, if necessary, professionally serviced.

The descriptions below and on the next pages will help you become familiar with the different systems. To ensure long, reliable operation, be sure to follow the few simple maintenance steps outlined for your particular system.

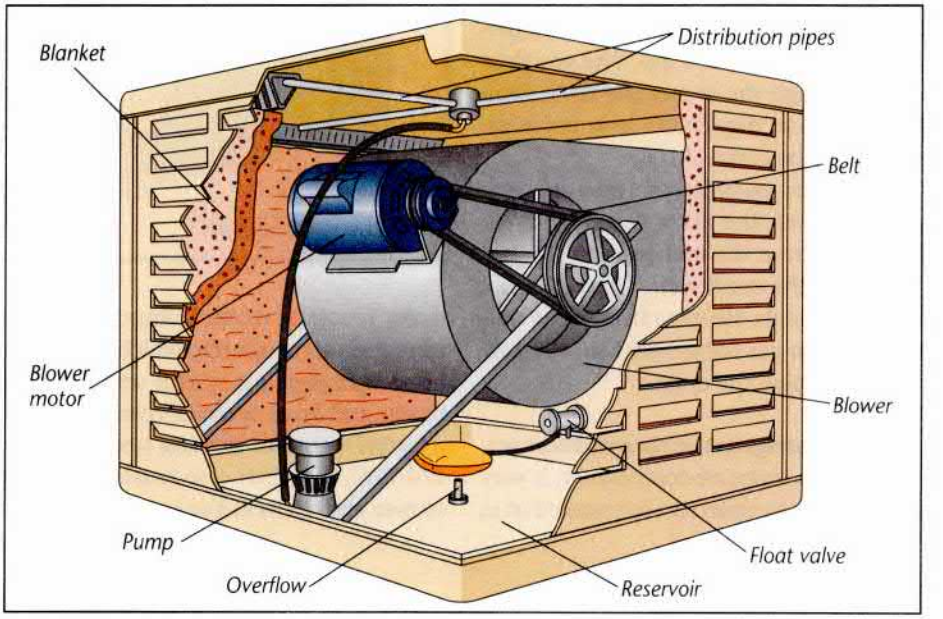
Evaporative Air Conditioners

In hot, dry areas, evaporative air conditioners are the most efficient way to cool a home. The unit is mounted in full sun on the roof or beside the house.

Inside the unit, water is sprayed on porous, absorbent blankets. Hot air from outside the house, pulled through the blankets by a blower, causes the water to evaporate, cooling the air. The cool air then enters the house, forcing stale air out through open windows.

With conscientious maintenance, you can expect few problems. At the beginning of each cooling season, and more often if you see a mineral buildup from the evaporated water, thoroughly clean the unit, oil the pump and blower, and replace the blankets. Also, check and adjust the blower belt; if it's cracked or worn, replace it as for a belt in a warm-air furnace *(page 174)*.

A typical evaporative air conditioner



How a Heat Pump Works

Basically, a heat pump is a refrigerated air conditioning system in which the air flow is instantly reversible.

During warm weather, the pump draws heat from the air inside the house, cooling it and transferring the heat to the outside or to a large solar mass. During cool weather, the flow is reversed—heat extracted from the outside air or from a large solar mass heats the air inside the house. Once the thermostat is set at the desired temperature, the heat pump automatically heats or cools your house as required.

Where temperatures below 0°F are common, some other supplemental heat source is required. Whenever the heat pump cannot extract enough heat from the outside air, the supplemental system turns on.

If you add an electric air cleaner and, to compensate for dry winter air, a humidifier, your heat pump system will provide clean air at the correct temperature and humidity for 24 hours a day.

Be sure to keep the outdoor portion of the heat pump free of snow and debris. Occasionally check the blower and filter and replace the filter monthly during periods of heavy use.

...AIR CONDITIONING SYSTEMS

Refrigerated Air Conditioners

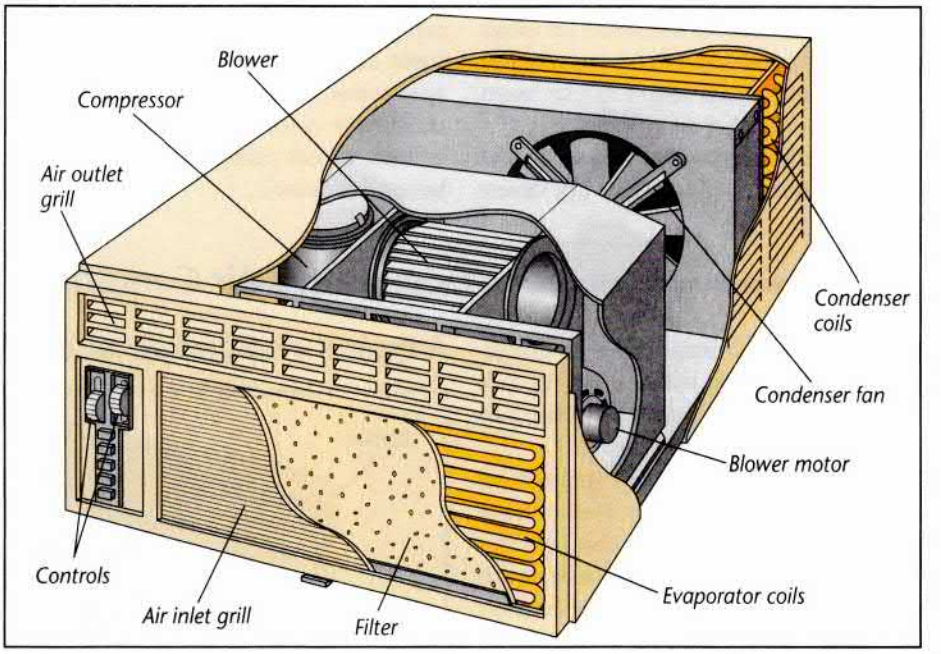
All refrigerated air conditioners, both room units and central systems, operate according to the same principle: They extract heat and moisture from the room air, cooling and dehumidifying it, then return the air to the room. Refrigerant, the same substance that's used in a refrigerator, circulates through the system.

How refrigerated systems work. Inside a refrigerated air conditioner are a compressor, evaporator or cooling coils, a condenser, and a connecting tubing; all are filled with refrigerant. Liquid refrigerant forced through a nozzle expands and partially vaporizes into a gas. The gas then flows through the evaporator coils, cooling the coils so they extract heat and moisture from the room air.

The warm gas then flows into the compressor, where the gas is heated by compression. From the compressor, the hot gas enters the condenser. There, the hot condenser coils dissipate heat to the outside and the gas condenses into a liquid, ready to repeat the cycle.

Types of refrigerated air conditioners. One type, a room air conditioner, is very easy to operate; units can be installed in as many rooms as needed. Another type is central air conditioning, which either can be an independent system with its own blower and ducts or can be combined with a forced warm-air heating system *(pages 174-175)*, in which case it uses the same blower and ducts as the heating system.

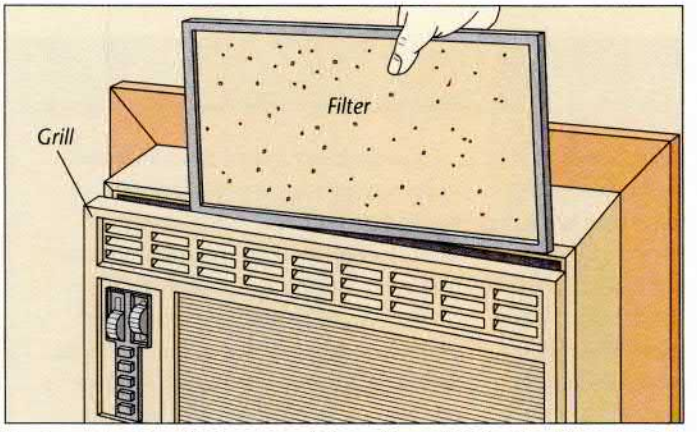
A typical room air conditioner



ROOM AIR CONDITIONERS

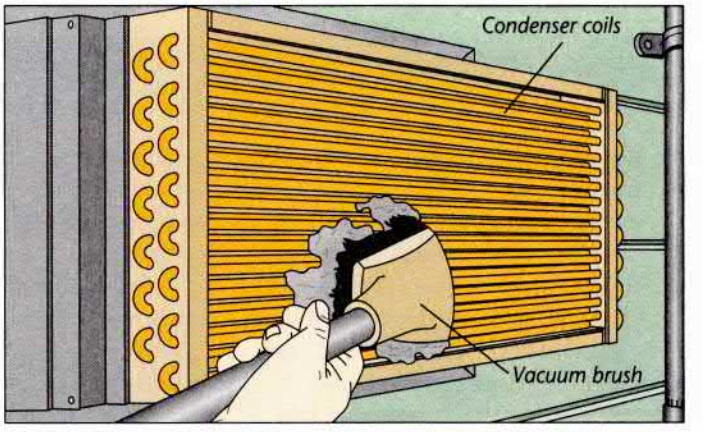
A room air conditioner is mounted in a window or wall; most of the unit projects outside the house. A blower in the unit sucks warm room air through a filter protected by a large inlet grill on the front of the unit; cool, dehumidified air returns

Cleaning the filter



To clean the filter, first remove it from the unit (the filter is accessible from top or side or, if necessary, by lifting off grill). Brush and vacuum the filter and replace it.

Cleaning the condenser coils



To clean the condenser coils, expose them by removing the access panels or the cover at the back of the unit; brush and vacuum the coils. Reassemble.

to the room through outlet grills. Water condensing on the evaporator coils drains outside and a fan blows outside air around the condenser coils to dissipate heat.

Room air conditioners generally require little maintenance. During the cooling season, clean the filter and condenser coils every month *(see facing page, bottom)*; replace the filter as necessary. You can reach the filter either through a slot on the side or top or by removing the grill. To reach the condenser, remove the back of the outside housing. Any problems you have with the refrigeration system are best left to a professional.

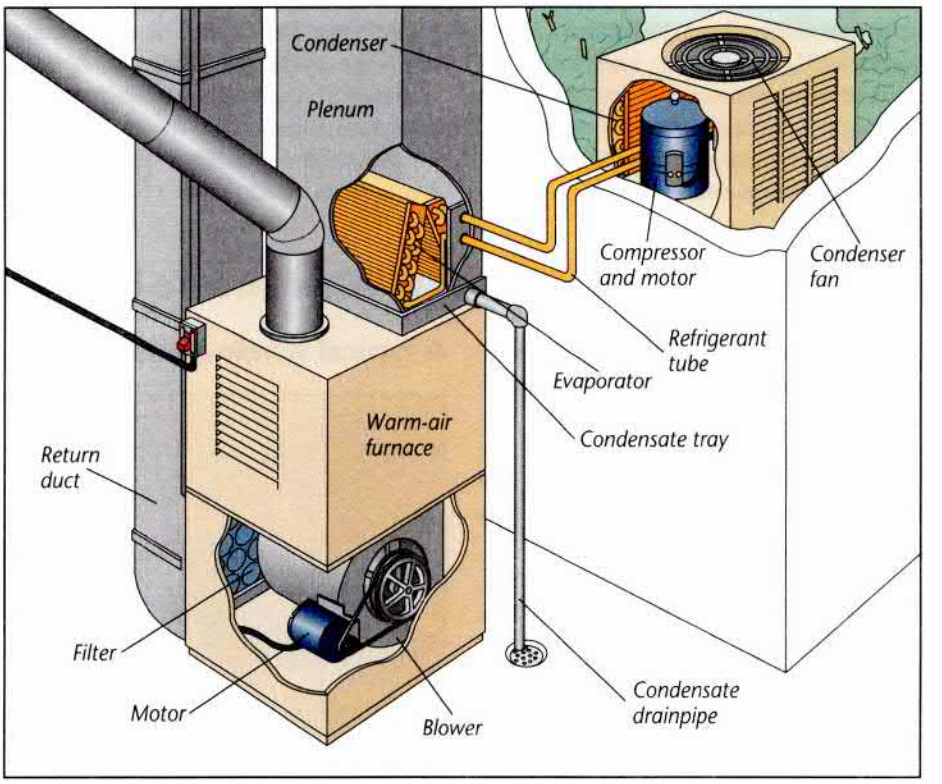
CENTRAL AIR CONDITIONERS

Though the initial expense is higher, central air conditioning is generally more efficient, quieter, and less costly in the long run than individual room units.

In a house without forced warm-air heat, a central air conditioner can be a single unit installed next to the house or a split unit, with the condenser and compressor outdoors and the evaporator and blower inside.

For a house heated with forced warm air, the most economical installation is a split system *(shown at right)*. The evaporator is mounted in the plenum of the furnace and the condenser and compressor are located outside the house.

A split-type central air conditioner



To ensure efficient operation, clean the filter every month during the cooling season; replace the filter as necessary. Check that the condensate drain is clear and that the condenser and evaporator coils are clean. When you vacuum the coils, be careful not to damage or deform the fins.

For problems with the operation of your air conditioning system, see the chart below. Call in a professional to repair the refrigeration system.

Troubleshooting a refrigerated air conditioner

PROBLEM	POSSIBLE CAUSE	REMEDIES
Air conditioner doesn't work	No power	Check circuit breaker or fuse *(pages 151-152)*
	Defective room unit power cord	Replace cord
Air conditioner doesn't cool or cools ineffectively	Thermostat set to heat	Reset to cold
	Insufficient air flow	Clean or replace filter, and clean evaporator and condenser coils *(see text)*
	Defective thermostat	Clean thermostat *(page 180)* or replace
	Defective compressor	**Repair compressor***
	Dirty or bent evaporator or condenser fins	Clean or straighten fins
	Frost on evaporator coils	Don't operate in temperatures below 60°F
Air conditioner excessively noisy	Dirty or bent fan blades	Clean or straighten fan blades
	Loose blower motor	Tighten mounting bolts
	Insufficient lubrication in motor	Place oil in oil cups, if any

**This repair is best left to a professional.*

VENTILATION

Proper ventilation in a home can replace warm air with cool, remove odors and excess moisture from the kitchen, bathroom, and laundry room, and reduce the level of heat and humidity in an attic as well as in a basement or crawl space.

Passive ventilators are simply openings in the walls and roof that allow heat to escape. Since these may be inadequate in warmer climates, mechanical ventilators—whole-house fans, attic fans, and exhaust fans—are often installed in homes. Mechanical ventilators, also called ventilating fans, remove hot, moist, or stale air and replace it with fresh air from the outside or from another part of the house.

With proper care, you can expect years of trouble-free service from your mechanical ventilator. Maintenance and repair procedures are uncomplicated and well within the skills of most homeowners. If you experience a problem with your ventilator, the chart on the facing page will help you determine the cause and remedy.

Whole-house Fans

Even though the outside air may be cooler after the sun goes down, the heat accumulated in a house during the day dissipates slowly, and the living areas may remain uncomfortably hot. Within a few hours, a whole-house fan can reduce the temperature inside by up to 25°F.

How whole-house fans work. These fans, designed for warm climates, pull hot air from the house through a ceiling opening and exhaust the air through attic vents. Louvers on a shutter under the fan open automatically when the fan turns on and close, sealing the opening, when the fan stops. The air exhausted by the fan is replaced by cooler outside air entering through open windows and doors.

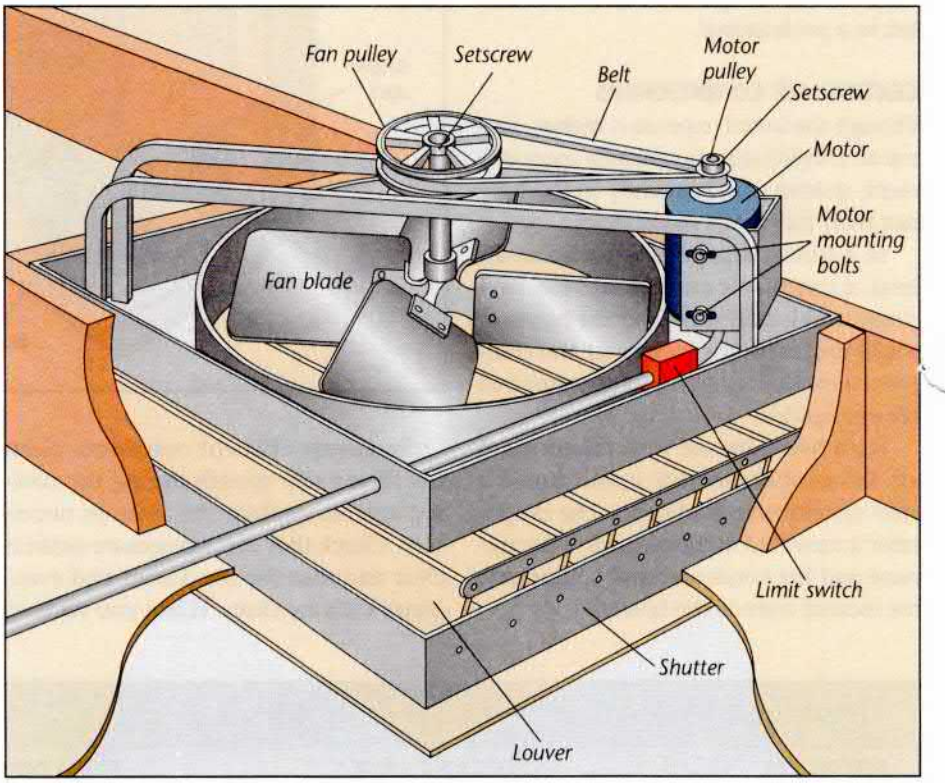
Usually, whole-house fans are mounted in a central location on the attic floor. But sometimes this type of fan is mounted in a gable. In this case, all other attic vents must be sealed so air is pulled only from the living area.

A switch or timer, conveniently located in the living area, controls the operation of the fan. For safety, a limit switch should be provided so the high temperature caused by a fire will shut off the fan and close the shutter.

When you turn on the fan, make sure a sufficient number of doors and windows are open to provide a free flow of air—the openings should at least equal the area of the fan, twice the area if the doors and windows are screened.

Because you probably won't want to turn on the fan during the heat of the day, this type of fan will not prevent the attic from overheating as does an attic fan.

A typical whole-house fan



Maintaining a whole-house fan. Generally, whole-house fans operate reliably for years, providing they're looked after at least once a year. The best time to perform the routine maintenance procedures outlined below is before the beginning of each cooling season.

- Shut off power to the fan.
- Clean the fan blades and louvers.
- Lubricate the fan and motor bearings (unless they're sealed) by squirting oil in the oil cups.
- Tighten all screws and bolts, especially the setscrews securing the pulleys to the motor and fan shafts.
- Check the belt; replace it as you would a blower belt if it's cracked or worn *(page 174)*.
- Check the belt tension by pressing in on the middle of the belt—it should deflect 1/2 to 3/4 inch. If it doesn't, loosen the mounting bolts and reposition the motor until the correct tension has been reached.
- Clean all the screens covering the vents in the attic.

Attic Fans

Though most attics have openings for ventilation, in warmer climates these usually are not enough to prevent the attic temperature from reaching 140°F or higher on a hot day. This heat seeps into the living areas below, causing discomfort for the occupants. With an attic fan (also called a roof fan), you can substantially reduce the temperature of the attic air.

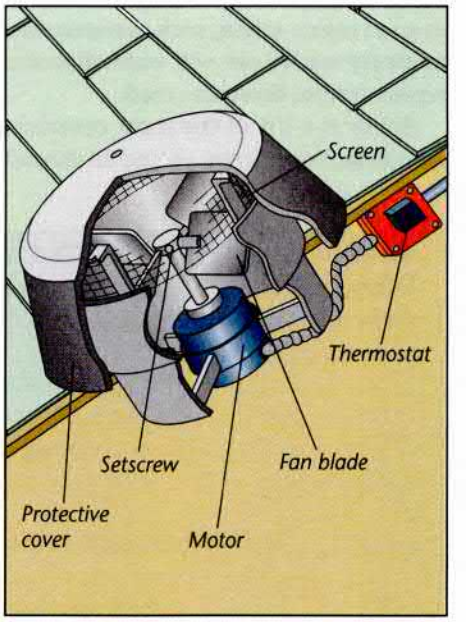
How attic fans work. Mounted as high as possible in a gable or roof surface, an attic fan exhausts hot attic air and pulls in cooler outside air through vents in the eaves or soffits and the other gables. Such a fan can reduce the attic temperature 20 percent or more and room temperatures as much as 10°F.

Smaller than a whole-house fan, an attic fan also moves much less air. The fan blade is mounted directly on the motor shaft. A thermostat in the fan housing or nearby in the attic turns the fan on at a preset temperature and turns it off when the attic temperature returns to normal.

Caring for an attic fan. Perform the following routine maintenance (work on the fan from the attic or, after removing the protective cover, from the roof) at the beginning of each cooling season:

- Shut off power to fan.
- Clean the housing and fan blades.
- Clean the screens on the fan and on the attic vents.
- Tighten all screws and bolts, especially the setscrew securing the blade assembly to the motor shaft.
- Lubricate the motor bearings (unless they're sealed) by squirting oil in the oil cups.

A typical attic fan



Exhaust Fans

Exhaust fans remove moisture, heat, and odors from kitchens, bathrooms, basements, and laundry rooms. They also help remove grease particles from kitchens. Quite small compared to attic and whole-house fans, exhaust fans are installed in a wall or ceiling, except for fans suspended in a range hood.

How exhaust fans work. Both wall-mounted fans and ceiling-mounted fans exhaust should exhaust through a duct to the outside. (Fans should never exhaust into the attic.) A fan in a range hood may exhaust through a duct or only recirculate the air through a charcoal filter without removing heat or moisture.

Caring for exhaust fans. Clean the grill and fan blades of a regular exhaust fan once or twice a year. Every 2 months wash the grease filter in a range hood fan; every 6 months wash the fan blades and housing. (Soak removable parts in soap and water.) Replace the pellets in a recirculating fan's charcoal filter annually.

Troubleshooting a mechanical ventilator

PROBLEM	POSSIBLE CAUSE	REMEDIES
Fan doesn't operate	(W) (A) No power	Check circuit breaker or fuse *(page 151-152)* (W) Replace switch *(158-159)* or timer (A) **Replace thermostat***
	(W) Tripped limit switch	Reset limit switch
	(W) (A) Defective motor	**Replace motor or fan***
Motor operates but no air flow	(W) Broken belt	Replace belt as for blower *(page 174)*
Insufficient air flow	(W) Loose belt	Tighten belt *(see text)*
	(W) (A) Clogged exhaust vents	Clean vents *(see text)*
	(W) (A) Inadequate intake openings	(W) Open some doors or windows (A) Clean attic vents

(W) Whole-house fan *(A) Attic fan* ***This repair is best left to a professional.***

YEAR-ROUND MAINTENANCE CHART

The saying "an ounce of prevention is worth a pound of cure" may be a cliché, but it's useful advice. Preventive maintenance is the best way to keep your home in good repair. Often, such maintenance routinely carried out will ward off major repairs further down the road.

Below is a list of the most common maintenance work you should do around the home. The chart is merely a guide; if you notice a problem developing, take care of it immediately.

Repairs and maintenance information for specific systems, appliances, and parts of the house are discussed throughout the book. Because all these items vary in design, the final authority—if available—should be the owner's manual.

CAUTION: Before inspecting or working on the electrical system or on any device connected to it, shut off the power *(page 152)* and check that the circuit is dead with a circuit tester, or unplug the device. For maintenance of or repairs to plumbing fixtures or water-using appliances, you may need to shut off the water *(page 7)*. To turn off the gas, see page 9.

WHEN	WHERE TO CHECK	WHAT TO DO
Every month (when in use)	Fire extinguisher	Check that it's fully charged and recharge if necessary
	Smoke detector	Test batteries and replace if necessary; test unit with a lit cigarette or incense
	Sink and tub stoppers	Clean out debris
	Garbage disposer	Flush with hot water and baking soda
	Steam heating system	Check safety valve and steam pressure gauge and replace if necessary; check water level gauge and add water if needed; drain water until clear of sediment
	Hot water heating system	Test relief valve and replace if necessary; check pressure gauge and drain expansion tank if necessary
	Forced warm-air heating system	Clean or replace air filter; vacuum registers
	Evaporative air conditioner	Check blankets and replace if necessary; check air flow; clean or repair unit if necessary
	Heat pump	Clean or replace air filter; clean condenser or evaporator coils and condensate drain; remove snow and/or debris from outdoor portion of unit
	Refrigerated air conditioner	Clean or replace filter; clean condenser and evaporator coils and condensate drain
Every 2 months (when in use)	Oil burner (pressure type)	Inspect and clean
	Wall furnace	Clean grills
	Range hood fan	Clean grease filter
Every 3 months	Faucet	Clean aerator
	Tub drain assembly	Clean out debris; inspect rubber seal and replace if necessary
	Floor drain strainer	Clean out debris and scrub strainer
	Dishwasher	Clean strainer, spray arm, and air gap
Every 6 months	Basement and foundation	Check for cracks and moisture and repair if necessary
	Toilet	Check for leaks and repair if necessary.
	Interior caulking	Inspect caulking around tubs, showers, and sinks; replace if deteriorating
	Water heater	Drain water until clear of sediment; inspect flue assembly (gas heater)
	Garbage disposer	Tighten drain connections and fasteners
	Clothes washer	Clean water inlet filters; check hoses and replace if leaking
	Clothes drier	Vacuum lint from ducts and surrounding areas
	Refrigerator	Clean drain hole and pan (more often in warm weather); wash door gasket; vacuum condenser coils
	Wiring	Check for frayed cords and wires; repair if necessary
	Exhaust fan	Clean grill and fan blades
	Range hood fan	Wash fan blades and housing

WHEN	WHERE TO CHECK	WHAT TO DO
Every spring	Roof	Inspect roof surface, flashing, eaves, and soffits; repair if necessary
	Gutters and downspouts	Clean out (more frequently if necessary); inspect and repair weaknesses; check for proper drainage and repair if necessary
	Siding	Inspect and clean siding and repair if necessary
	Exterior caulking	Inspect caulking and replace if deteriorating
	Window sills, door sills, and thresholds	Fill cracks, caulk edges, repaint; replace if necessary
	Window and door screens	Clean screening and repair or replace if necessary; tighten or repair any loose or damaged frames and repaint if necessary; replace broken, worn, or missing hardware; tighten and lubricate door hinges and closers
	Drain-waste and vent system	Flush out system
	Hot-water heating system	Lubricate circulating pump and motor
	Evaporative air conditioner	Clean unit; check belt tension and adjust if necessary; replace cracked or worn belt
	Heat pump	Lubricate blower motor
	Refrigerated air conditioner	Lubricate blower motor
	Whole-house or attic fan	Clean unit; check belt tension and adjust if necessary; replace cracked or worn belt; tighten screws and bolts; lubricate motor bearings
Every autumn	Roof	Inspect roof surface, flashing, eaves, and soffits; repair if necessary
	Gutters and downspouts	Clean out (more frequently if necessary); inspect and repair weaknesses; check for proper drainage and repair if necessary
	Chimney/stovepipe	Clean flue (more frequently if needed); repair any cracks in flue or any loose or crumbling mortar
	Siding	Inspect and clean siding and repair if necessary
	Exterior caulking	Inspect caulking
	Storm windows and doors	Replace any cracked or broken glass; tighten or repair any loose or damaged frames and repaint if necessary; replace broken, worn, or missing hardware; tighten and lubricate door hinges and closers
	Window and door weatherstripping	Inspect and repair or replace if deteriorating
	Drain-waste and vent system	Flush out system
	Hot-water heating system	Lubricate pump and motor; bleed air from radiators or convectors
	Forced warm-air heating system	Vacuum heat exchanger surfaces; clean and lubricate blower blades and motor; check fan belt tension and adjust if necessary; replace cracked or worn belt; check for leaks and repair if necessary
	Gas burner	Clean burners and ports
	Oil burner	Have professionally serviced
	Thermostat	Clean heat sensor, contact points, and contacts; check accuracy and replace if necessary
	Garage doors	Clean and lubricate hinges, rollers, and tracks; tighten screws
Annually	Septic tank	Have a professional check tank (watch for back-up throughout the year)
	Water heater	Test temperature-pressure relief valve and replace if necessary; clean burner and ports (gas heater)
	Refrigerator	Test door seal (replace gasket about every 6 years); check temperature and adjust if necessary
	Recirculating fan (range hood)	Replace pellets in charcoal filter

GLOSSARY

Abrasive. Substance, such as sandpaper, that wears away a surface by scraping or friction

Ampere. Measurement of electrical current. Many elements in an electrical system and devices connected to it are rated in amperes for the greatest amount of electrical current they can safely carry (abbreviated "amp").

Bevel. To angle an edge (usually 45°) on a piece of wood or other material.

Blind-nail. To drive a nail into a piece of material (such as flooring or paneling) so the nail will be hidden when the next piece is installed.

Blower. Motor-driven fan that moves air through the ducts of a heating or cooling system or through vents.

Bond. Adhesion of glue or other adhesive to materials being joined; pattern formed in laying brick or other masonry units.

Circuit. Two or more wires that provide a path for electrical current from a source through some device using electricity (such as a light) and back to the source.

Circuit breaker. Automatic safety switch installed in a circuit to break the flow of electricity when the current exceeds a predetermined safe amount.

Cleanout. Opening that provides access to a drainpipe or to a trap under a sink and that's sealed with a threaded plug.

Combustion chamber. Fireproof compartment in a boiler or furnace that contains the flame of an oil or gas burner.

Convector. Type of radiator (used in a hot-water heating system) that transfers heat to a room by air convection.

Cope. To saw the end of a piece of molding so it conforms exactly to the face of another piece of molding to form a right-angle joint.

Counterbore. To drill a hole for a screw so that the head can be driven below the surface.

Countersink. To drill a hole for a flathead screw so the head will be flush with the surface; to install a nail so its head is below the surface.

Coupling. Fitting used to connect two lengths of pipe.

Course. Horizontal row of shingles or shakes, brick or other masonry units, siding materials, ceramic wall tiles, or ceramic, wood, or resilient floor tiles.

Damper. Flat plate that opens and closes to control amount of air flowing through a heating duct, exhaust vent, flue, or chimney.

Dowel. Cylindrical wood peg fitted into a hole drilled through two pieces of wood to prevent slippage.

Duct. Large channel through which air passes in a heating, cooling, or exhaust system.

Escutcheon. Decorative metal piece that fits over or around a pipe protruding from a wall, or over a faucet body, or around a lockset on the face of a door.

Face-nail. To nail into the face of a piece of wood or other building material.

Flange. Projecting rim or collar, such as on a skylight, that aids attachment or increases stiffness.

Furring strips. Thin, narrow pieces of wood fastened to studs or joists to even out a surface and/or provide a nailing base for finish materials.

Fuse. Safety device in an electric circuit designed to either blow or open and stop the flow of electricity when current exceeds a predetermined safe amount.

Gasket. Material (often rubber) that is installed between two parts to make a joint leakproof.

Glazier's points. Small metal pieces used to hold a glass pane in a window sash until putty is applied.

Graphite. Fine black lubricating powder used dry or mixed with oil.

Ground. To connect any part of an electrical wiring system to a ground, either a cold water pipe or a long metal rod driven solidly into the soil, to keep metal parts of a wiring system at zero volts.

Gypsum board. Large panel composed of a fire-resistant gypsum core sandwiched between two layers of heavy paper and used as a finish for walls and ceilings, or as a backing for other wall and ceiling materials.

Joint compound. Plaster-like material used along with wallboard tape to fill and finish joints between gypsumboard panels.

Joists. Evenly spaced, horizontal lengths of lumber that provide structural support for floors and ceilings.

Level. To determine if a surface is exactly horizontal or if two or more points are exactly the same height.

Locknut. Nut used to hold a threaded part, such as another nut, in position or to prevent another nut from turning on a screw or bolt.

Masonry. Brick, stone, concrete, or concrete block building material used for walls, floors, and paving.

Milling. Process that imparts a smooth surface to a piece of lumber; process that lends decorative shape to a piece of wood, such as molding.

Miter. To cut ends of two pieces of wood at an angle so they can be joined to form a corner.

Molding. Milled piece of lumber, either recessed or relieved, used to hide a joint or add a finished look.

Mortar. Mixture of cement, sand, water, and sometimes lime used as an adhesive for laying brick, stone, ceramic tile, and concrete block.

Mortise. Recess made in a piece of wood to receive a lockset, hinge, or other piece of hardware.

Penetrating oil. Oil used to loosen joints—particularly rusted ones—between metal parts.

Pilot flame. Small gas flame or electric spark that ignites a gas burner in a range, water heater, dryer, furnace, or boiler.

Pilot hole. Starter hole drilled into wood or metal before inserting a screw or nail; prevents fastener from splitting wood. Diameter of hole must be smaller than fastener.

Pilot orifice. Small hole in a pilot through which gas passes before igniting.

Plenum. Enclosed chamber in furnace where warm air is distributed to ducts.

Plumb. To determine if a vertical surface is exactly perpendicular (90°) to a horizontal plane.

Prime. To apply an undercoat of paint or sealer to seal pores of wood and provide a surface to which finish coats can adhere.

Pulley. A wheel grooved to receive a cord, cable, or belt, such as in a window sash, roll-up garage door, or blower.

Receptacle. Device in an electric wiring system to which a lamp, appliance, or extension cord is connected by means of a plug on the end of a cord.

Refrigerant. Substance used in a refrigerator or air conditioner that absorbs and releases heat.

Register. Grill at end of a supply or return duct in a forced warm-air heating system or refrigerated air conditioning system through which air enters or leaves a room.

Roofing cement. Black elastic waterproofing compound used in flashing and roofing installations, and for repairs.

Roofing felt. Thick, fibrous paper impregnated with asphalt used between roof deck and some roofing materials.

Sash. Part of a window that holds the glass and is supported by the frame.

Score. To cut or scribe a fine line on a surface in order to facilitate cutting or to mark a cutting or location line.

Screed. To bring a fill material flush with the surrounding surface.

Self-tapping screw. Screw that cuts its own thread in metal when driven into a pilot hole.

Setscrew. Headless screw used to hold two metal parts together, such as a pulley on a shaft, a handle on certain faucets, or a socket on a light fixture.

Shim. Small, thin piece of wood, cardboard, or metal; to use these pieces to adjust level, plumb, or alignment.

Shutoff valve. Device that controls flow of water or gas to an individual fixture or appliance or to the entire system.

Soil stack. Large drain-waste and vent pipe that connects toilet and branch drains to main house drain and extends out of the roof.

Solar mass. Large amount of material such as water, rock, or masonry in a solar-heated home that absorbs and stores heat from the sun and releases it when needed.

Splice. To join wires by twisting and soldering or with solderless connectors such as wire nuts.

Stucco. Plaster made from a mixture of cement, sand, and water applied over wood or metal lath, wire mesh, or masonry as an exterior finish.

Studs. Vertical pieces of lumber usually spaced on 16- or 24-inch centers and attached to top and sole plates, forming the structural core of interior and exterior walls of a house.

Subfloor. Boards, planks, or plywood nailed to floor joists to provide structural rigidity and a base for finish flooring.

Texture. To form a patterned, raised surface on stucco, plaster, gypsum board, or paint.

Thermocouple. Device in a gas burner which by converting the heat of a pilot flame into electricity controls a gas valve that assures the gas is shut off if the pilot is extinguished.

Thumbscrew. Screw with a special head that can be turned with thumb and forefinger.

Toenail. To drive a nail at an angle through a vertical piece of lumber, such as a stud, into a horizontal piece, such as a sole or top plate.

Tool. To finish a mortared joint in masonry, leaving an impression of the finishing tool.

Transformer. Electrical device that raises or lowers voltage in a circuit.

Trap. U-shaped section of pipe located between a fixture or appliance and a branch drain that holds water, forming a seal to prevent sewer gas from entering through fixture drain.

Undercut. To cut away inner edges of a crack or hole in the shape of an inverted V in order to provide a stronger base for patching material.

Valve. Device in a heating or plumbing system that controls the flow of a liquid or gas.

Vaporize. To convert a liquid into a gas, usually by application of heat.

Vent stack. Pipe that rids plumbing system of sewer gas and prevents pressure buildup in pipes.

Volt. Unit of measurement denoting electrical pressure or potential (usually abbreviated "V").

Voltage. Electric potential or pressure at which a circuit or device operates, expressed in volts.

Washer. Flat disc with a center hole used under a screw, bolt, or nut.

Wet-sanding. Using water and fine sandpaper with a waterproof backing, known as wet-or-dry paper, to achieve a smooth finish on joint compound without clogging the sandpaper's abrasive grains.

Wire nut. Plastic or plastic-and-metal connector used to splice two or more wires without solder.

Wood preservative. Chemical applied to wood to protect it from insects, dry rot, and moisture.

Worm gear. Toothed-gear-and-screw combination found in casement window operators and in tilt mechanisms of venetian blinds.

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